LIBERIA
NATIONAL ADAPTATION PLAN
2020 – 2030

FOREWORD

Climate change has contrary impacts on our country's economic development. It threatens the realization of our Vision 2030 goals of creating a competitive and prosperous nation with a high quality of life. Liberia's economy is highly reliant on natural resources. Unpredictable rainfall patterns and floods will continue to impact the livelihoods and community assets negatively.

The Government of Liberia recognizes the threats posed by climate change and has taken action to address them. In this regard, the EPA coordinated the development of the National Climate Change Response Strategy in 2018. This National Adaptation Plan (NAP) marks a fundamental landmark in addressing its susceptibility and resilience to climate change.

The NAP was developed through a cooperative and consultative process that included stakeholders from the Government, the private sector, and civil society, with the United Nations Development Programme's support. The UNDP supports NAP implementation through the design, financing, and implementation of priority actions. Effective implementation of the NAP will be supported by establishing enabling governance structures, including those set out in the Climate Change Act enacted into law. Additional support and increased partnerships will be required for Liberia to achieve its adaptation goals.

The Government of Liberia is fully committed to addressing climate change domestically and demonstrating leadership in the global fight against climate change. This document forms a critical part of Liberia's response to climate change, fulfilling the mandate of the Climate Change Act, and reflecting Liberia's commitment to fulfilling its international obligations in line with the UNFCCC.

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- Muyambi Fortunate, 2020; "Mainstreaming climate change considerations into the relevant sector specific development programs, policies, strategies, and management plans in Liberia"
- D. Enoch Foday; 2020; "Climate vulnerability and risk assessment for the Waste Management and Energy Sectors of Liberia"
- 2020; "National Disaster Risk Reduction and Resilience Strategy of Liberia (2020-2030)"
- Dr. Vladimir Kalinski; 2019; "Climate Hazard, vulnerability and risk assessment for the coastal zone of Liberia"
- Prof. Kalame Fobissie, John Kannah, Harrison Luo; 2019; "Climate vulnerability and risk assessment for the sectors of agriculture, fisheries, and forestry in Liberia"
- 2019; "Gender and Social Impact of Climate Change in Liberia"
- 2019; "Guidelines for mainstreaming climate change adaptation into National Budget and Planning in Liberia"
- Chantal Kingue Ekambi; 2018; "Guidelines in Mainstreaming Gender in Climate Change National and Sectoral Adaptation Plans for Monitoring and Evaluation and Planning Staff"

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EXECUTIVE SUMMARY

Like many other countries globally, Liberia is increasingly experiencing physical changes to its climate stemming from anthropogenic global warming[1]. These **physical changes** include warmer temperatures, increases in annual rainfall, and increases in the frequency of heavy rainfall events. Though historically Liberia's contribution to atmospheric greenhouse gas (GHG) concentrations has been negligible, our country is unfortunately confronted with the daunting challenge of adapting to these new climatic conditions and their impacts.

Recognizing the implication of climate change for its national development and in response to its international commitments, the Government of Liberia (GoL), through the Environmental Protection Agency (EPA), has taken various actions to support climate change adaptation planning with several climate-related policies. Liberia has undertaken climate vulnerability assessments and risk on several priority sectors to support these policies, including coastal zones, agriculture, waste management, forestry, and fisheries. Under the EPA's guidance and support from the United Nations Development Programme (UNDP), the GoL has prepared this National Adaptation Plan (NAP) framework to guide and advance its National Adaptation Plan process medium- and long-term adaptation needs in a coherent and coordinated manner.

The purpose of this document is to provide an overall framework to guide the country in developing, coordinating, and implementing its NAP process. This document describes the benefits of the NAP process in the context of Liberia. It ensures that the NAP process does not unnecessarily add to the proliferation of national planning processes and related documents. Instead, the NAP process aims to strengthen existing planning processes by integrating climate change adaptation considerations. Specifically, the objectives of this NAP process are to:

- Provide a framework and procedures for sharing of information of scientific, technical, and traditional knowledge on climate change risk management and develop capacity-building measures;

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[1] ***Global warming*** *refers to the overall increase in average global temperatures due to increased greenhouse gas (GHG) concentrations in the atmosphere. The effects of global warming in Liberia are shaped by a variety of regional and local factors (e.g., proximity to the ocean, wind patterns, topography).* ***Climate change*** *refers to the way that global warming is manifested in each area.*

- coordinate sectors (including both public and private sector stakeholders) as well as institutions on climate change risk management and universities using awareness with a focus on the improvement of climate risk management actions; and
- Encourage participation from sector stakeholders and line agencies responsible for key sectors to identify and propose measures to promote adaptation to reduce climate change risk.

The NAP Process will implement a sectoral-based approach to climate change adaptation planning in Liberia, with adaptation priorities identified for crucial sectors such as agriculture, forestry, energy, fisheries, coastal zones, and waste management. The NAP Process also outlines the alignment between existing national, regional, and international policies and legal frameworks.

This document's methodology consisted of an extensive desk review covering a wide range of sources, including national policy documents related to climate change, priority sector strategies and plans, NGO and development partner analyses, academic and research studies and articles, project documents (including those from UNDP's NAP support project), and analyses of stakeholder consultation meetings and the national validation workshop. The desk review was complemented by consultations with stakeholders drawn from the priority sectors (public and private), NGOs, CSOs, academicians, and line agencies relevant to climate change adaptation identified by the EPA and NAP manager. The EPA was also consulted on the structural design of the document. The NAP process's consultation included extensive discussions with experts on climate change in Liberia. They had non-expert voices from a wide range of stakeholder groups to ensure that the formulation of the framework is inclusive and reflective of diverse perspectives. This phase also included working with relevant technical partners, institutions, and experts to identify broader climate change issues.

Finally, fundamental to the success of the NAP process in Liberia will be: i) addressing capacity gaps and weaknesses in climate change adaptation among line ministry and agencies in Liberia; ii) identifying and appraising adaptation options at the sectoral, sub-national, and national levels; iii) creating an enabling environment for effective institutional functioning and capacities for adaptation; iv) designing a coherent approach to mobilizing funding for effective climate change adaptation; v) developing innovative strategies for engaging the private sector; and, vi) developing an effective monitoring and evaluation system to facilitate implementation.

Adaptation is not a one-off action but is instead a process that requires adaptive management reflecting unfolding climate impacts, normative nature of risk tolerance, and the tipping points. The United Nations Framework Convention on Climate Change (UNFCCC) recognizes the importance of learning and capacity building to respond to climate change. Article 6 notes the aim to facilitate training of 'scientific, technical and managerial personnel to implement sustainable climate change adaptation programme.

Understanding the causes and potential consequences of global climate change on people and the environment is essential in implementing strategies to reduce climate change in the future.

ACRONYMS AND ABBREVIATIONS

AEZ	Agro-ecological Zones
AFT	Agenda for Transformation
AR4	Fourth Assessment Report of the IPCC
AR5	Fifth Assessment Report of the IPCC
BNF	Bureau of National Fisheries
CDM	Clean Development Mechanism
CoP	Conference of Parties (to the UNFCCC)
CPEIR	Climate Public Expenditure and Institutional Review
CSO	Civil Society Organization
CBA	Community Based Adaptation
DNA	Designated National Authority (to the UNFCCC)
EbA	Ecosystem Based Adaptation
EKMS	Environmental Knowledge Management System
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organization
FDA	Forest Development Authority
GCF	Green Climate Fund
GCM	Global Climate Model
GEF	Global Environment Facility
GHG	Green House Gases
GoL	Government of Liberia
HDI	Human Development Index
IBA	Importance Bird Areas
IDP	Internally Displaced People
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-tropical Convergence Zone
IUCN	International Union on the Conservation of Nature
LDC	Least Developed Country
LEG	Least Developed Countries Expert Working Group
LISGIS	Liberia Institute of Statistics and Geo-Information Services
LSA	Living Shoreline Approach

LWSC	Liberia Water & Sewer Corporation
MCC	Monrovia City Corporation
MFDP	Ministry of Finance and Development Planning
MICAT	Ministry of Information, Culture, and Tourism
MMA	Monrovia Metropolitan Areas
MGCSP	Ministry of Gender, Children, and Social Protection
MoH	Ministry of Health
MoME	Ministry of Mines and Energy
MoT	Ministry of Transport
MSW	Municipal Solid Waste
NaFAA	National Fisheries and Aquaculture Authority
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NBSAP	National Biodiversity Strategy and Action Plan
NCCS	National Climate Change Secretariat
NDMA	National Disaster Management Agency
NGO	Non-governmental organization
NPHIL	National Public Health Institute of Liberia
NPRSCC	National Policy Response Strategy to Climate Change
NRDP	National Reconstruction and Development Plan
NTFP	Non-timber Forest Products
PAPD	Pro-Poor Agenda for Prosperity
PPP	Public-Private Partnership
RCM	Regional Climate Models
RCP	Representative Concentration Pathway
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SDG	Sustainable Development Goals
UNDP	United Nations Development Programme
UNESCO	United Nations Education Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development

USDA	United States Department of Agriculture
WHO	World Health Organization

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DEFINITION OF TERMS (NPRSCC, 2018)

Adaptation: Adaptation to global warming refers to actions aimed at coping with climatic changes that cannot be avoided and aimed at reducing their negative effects. Adaptation measures include the prevention, tolerance, sharing of losses, changes in land use or activities, changes of location and restoration.

Adaptive Capacity: The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Climate Change: Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from:

- Natural Factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun.
- Natural processes within the climate system, such as changes in ocean circulation, human activities that change the atmosphere's composition through burning fossil fuels and land surface through deforestation, reforestation, urbanization, desertification, etc.

Climate Resilience: Climate Resilience can be used to describe a broader agenda than adaptation, as defined above. It captures activities which build the ability to deal with climate variability – both today and in the future. Climate resilience building activities include many existing development investments, including those in the agriculture, food security, health, land management and infrastructure sectors.

Climate Variability: Variations in the mean state and other statistics (such as standard deviations, the occurrences of extremes, etc.) of the climate on temporal and spatial scales beyond that of individual weather events.

Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). In simple terms climate variability refers to changes in patterns, such as precipitation patterns, in the weather and climate.

Emission: The release of a substance, usually a gas, when referring to the subject of climate change in the atmosphere.

Exposure: Exposure refers to the nature and degree to which a system is exposed to significant climatic variations.

Extreme Weather: Includes un-expectable, unusual, unpredictable severe or unseasonal weather such as floods, heat waves, cold-waves, heavy and devastating rainfall, tropical cyclones, etc.

Greenhouse Gases (GHGs): Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, but are not limited to, water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydro-chlorofluorocarbons (HCFCs), ozone (O_3), and hydrofluorocarbons (HFCs), per fluorocarbons (PFCs), and Sulphur hexafluoride (SF_6).

Intergovernmental Panel on Climate Change (IPCC): The IPCC was established jointly by the United Nations Environment Program (UNEP) and the World Meteorological Organization in 1988. The purpose of the IPCC is to assess information in the scientific and technical literature related to all significant components of the issue of climate change.

Climate Mainstreaming: The informed inclusion of relevant climate concerns into the planning and decisions of institutions that drive national, local, and sectorial objectives.

Resilience: The ability of a system to adapt to climate change, whether by taking advantage of the opportunities, or by dealing with their consequences.

Risk[2]: The potential for adverse consequences for human or ecological systems, recognizing the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change. Relevant adverse consequences include those on lives, livelihoods, health and wellbeing, economic, social, and cultural assets and investments, infrastructure, services (including ecosystem services), ecosystems and species.

[2] IPCC Glossary; IPCC, 2012: Glossary of terms. In: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation;* Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation — IPCC

Sensitivity: This refers to the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli, directly or indirectly.

Vulnerability: The degree of susceptibility to the negative effects of climate change. It is a function of the type, magnitude, and frequency of climate events to which a system is exposed (exposure), as well as sensitivity and capacity for adaptation (adaptive capacity

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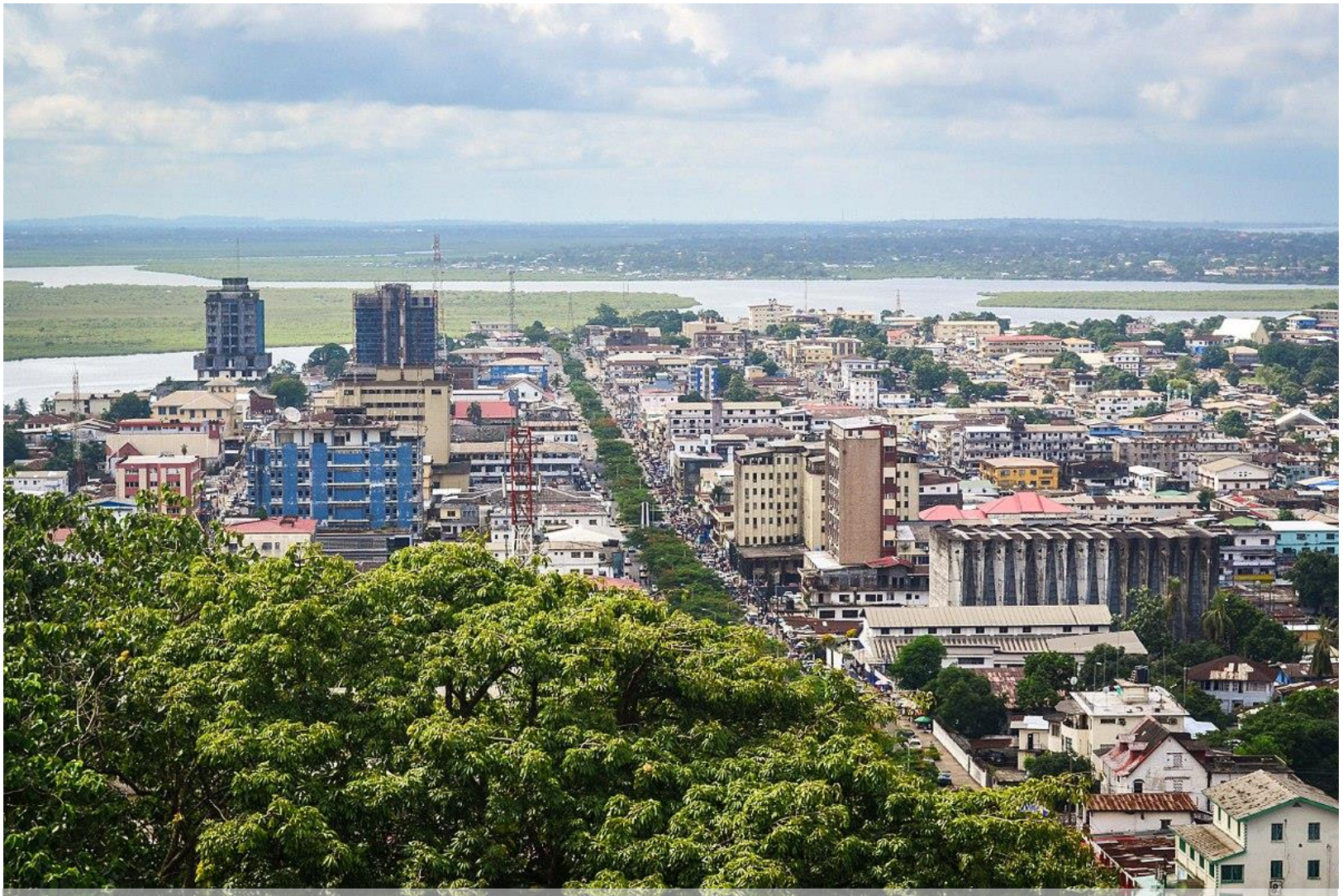


CHAPTER 1 INTRODUCTION

1.1. Overview

Liberia has made significant social and economic development progress since emerging from the civil war in 2003. Since the end of the civil war, Liberia has maintained a consistent upward trajectory concerning socio-economic development. According to UNDP's Global Human development report, the country's human development index (HDI) has increased at a rate of more than 2% annually. However, despite the progress made over the past two decades and the country's abundant endowment of natural resources and favorable geographic location. Liberia is challenged with climate change. Climate change is driven by anthropogenic global warming, leading to increased frequency of extreme events in various regions of Liberia and rainfall patterns, flooding, landslides, and consequent population displacement in the affected regions. Such changes will have severe consequences for society, ecosystems, and various sectors of the economy.

Climate change threatens to create a negative development trajectory with inter-generational impacts and fuel an ongoing cycle of poverty and underdevelopment. Liberia remains fragile due to several non-climate factors, including widespread poverty, high inequality and unemployment, and limited access to essential services (water, sanitation and energy). These non-climate factors combine with climate change processes to create significant vulnerabilities for Libera and the national and local levels. This vulnerability is exacerbated by high dependence on natural resource-intensive sectors that are climate-sensitive – such as agriculture, fisheries, and forestry– for economic growth and livelihood support (USAID, 2017b). Without practical actions to build resilience to the expected impacts of climate change, poverty and other socioeconomic issues will likely be worsened. As a result, Liberia's progress towards improving livelihoods and living standards for all Liberians will be undone.

Through the Environmental Protection Agency (EPA) and its partners, Liberia took its first coordinated steps to combat climate change by formulating the National Adaptation Programme of Action (NAPA) in 2008. The NAPA outlined Liberia's most urgent and immediate needs for climate change adaptation. After this, Liberia initiated the National Adaptation Plan (NAP) process in 2010 to establish a nationally coordinated approach to addressing the country's medium and long-term adaptation needs. Under the NAP process, the government (through EPA) has developed the National Policy Response Strategy of Climate Change (NPRSCC) and other relevant policy documents.

However, the challenges are significant. Climate change will be manifested in Liberia in rising sea levels, changing precipitation patterns, higher temperatures, and more extreme weather events such as heavy rains and droughts. Agricultural productivity, which already suffers from land degradation and extreme weather events, is even more vulnerable to a changing climate given its reliance on climate-sensitive staple crops such as rice. Climate change will make existing stressors worse, for example, by

contributing to the increased incidence of pests and diseases. Agriculture is also expected to be increasingly and negatively affected by the increased frequency and intensity of drought and floods due to expected long-term changes in rainfall patterns and shifting temperature zones. Saltwater and freshwater fisheries (USAID, 2017a), which are critical economic and nutritional resources, are likely to suffer as sea temperatures increase, as coastal ecosystems (mangroves and wetlands) are damaged, and as changes to temperature and precipitation regimes affect water quality and availability in Liberia's surface water resources.

These impacts are already being observed in Liberia. Climate change-induced extreme events limit the ability of communities to meet their basic needs due to a reduction in the amount of productive land and pest infestation of crops (NPRSCC, 2018).

The potential impacts of climate change worldwide constitute a significant concern (Godde et al., 2021). Moreover, as a critical factor of the earth's ecosystem, vegetation is sensitive to climate change, and its feedback has a pronounced effect on climate, hydrology, and ecology (Bao et al., 2021). Therefore, substantial emissions reductions over the next few decades can reduce climate risks in the 21st century and beyond, increase prospects for effective adaptation, reduce the costs and challenges of mitigation in the longer term and contribute to climate-resilient pathways for sustainable development warming increases.

Over the last 25 years, there has been minimal global progress in reducing greenhouse gas emissions such as carbon dioxide. Substantial investment has not been made to adapt our economies to future circumstances. Global warming, decreased biodiversity, water, and air pollution are already causing health problems and increasing mortality across the planet. These effects have manifested themselves more rapidly and intensively than previously expected, with impacts falling disproportionately on the shoulders of the most vulnerable and most disadvantaged people. The result is increased mortality and incidence of climate-related zoonosis, heat stress, more asthma, and allergies, with resultant loss of labor productivity. For the near future, an increased cardiovascular and pulmonary diseases, as well as mental ill-health, besides the health consequences of food insecurity, water shortage, climate migration, or territorial conflict (Ossebaard & Lachman, 2021) (Pathak, van Beynen, Akiwumi, & Lindeman, 2021).

As the impacts of climate change have become apparent around the world, adaptation has attracted increasing attention (AR5, 2014). As a result, adaptation to climate change is becoming a routine and essential component of planning at all levels (AR5, 2014;(LEG, 2012)). However, adaptive capacity is limited in the developing world and among the poorest of the poor. So, climate change impacts are expected to be particularly severe in these countries and among these groups.

Therefore, the need to reduce climate vulnerability and risk for the country and safeguard the country's social and economic growth trajectory against climate change remains a high priority. This

priority will be addressed through the NAP process. Risk management and implementing sectoral and thematic strategies for climate change adaptation will require coordination and cooperation among all government levels and civil society. This NAP Process describes Liberia's principal risks and vulnerabilities from climate change and proposes adaptation actions and strategies and capacity building for management to address the risks and vulnerabilities. The NAP focuses explicitly on six priority sectors that the Government of Liberia has identified through the Environmental Protection Agency: agriculture, coastal zones, forestry, energy, waste management, and fisheries. It also proposes institutional mechanisms for concerted deployment among counties and municipalities, economic sectors, and the public, and scheduled structural measures to overcome gaps observed in the national context.

1.2. National Adaptation Plans: General Description

The National Adaptation Plan process was established in 2010 as part of the Cancun Adaptation Framework to complement the existing short-term orientated, "urgent and immediate" focused National Adaptation Programmes of Action. It enables Parties to formulate and implement NAPs to identify medium- and long-term adaptation needs and develop and implement strategies and programmes to address those needs. It is a continuous, progressive, and iterative process that follows a country-driven, gender-sensitive, participatory, and fully transparent approach. The NAP process plays a critical role in reducing vulnerability and building adaptive capacity by mainstreaming adaptation into all sector-specific and national development planning. To guide developing countries in formulating their NAPs, the Least Developed Countries Expert Group (LEG) established clear guidelines and benchmarks (LEG, 2012).[3] The main objectives of NAP Technical guidelines according to UNFCCC and the LEG are:

1. To take a medium- and long-term approach to reducing vulnerability to climate change's adverse effects.
2. To facilitate the integration of climate change adaptation coherently into relevant new and existing policies, programs, and activities, particularly development planning processes and strategies, within all relevant sectors and at different levels, as appropriate.

The LEG guidelines are intended to assist LDCs in undertaking the steps and activities to ensure an effective adaptation response. Based on their different levels of progress with adaptation thus far, countries can select which actions and activities to undertake to move forward. Therefore, the NAP is developed so that

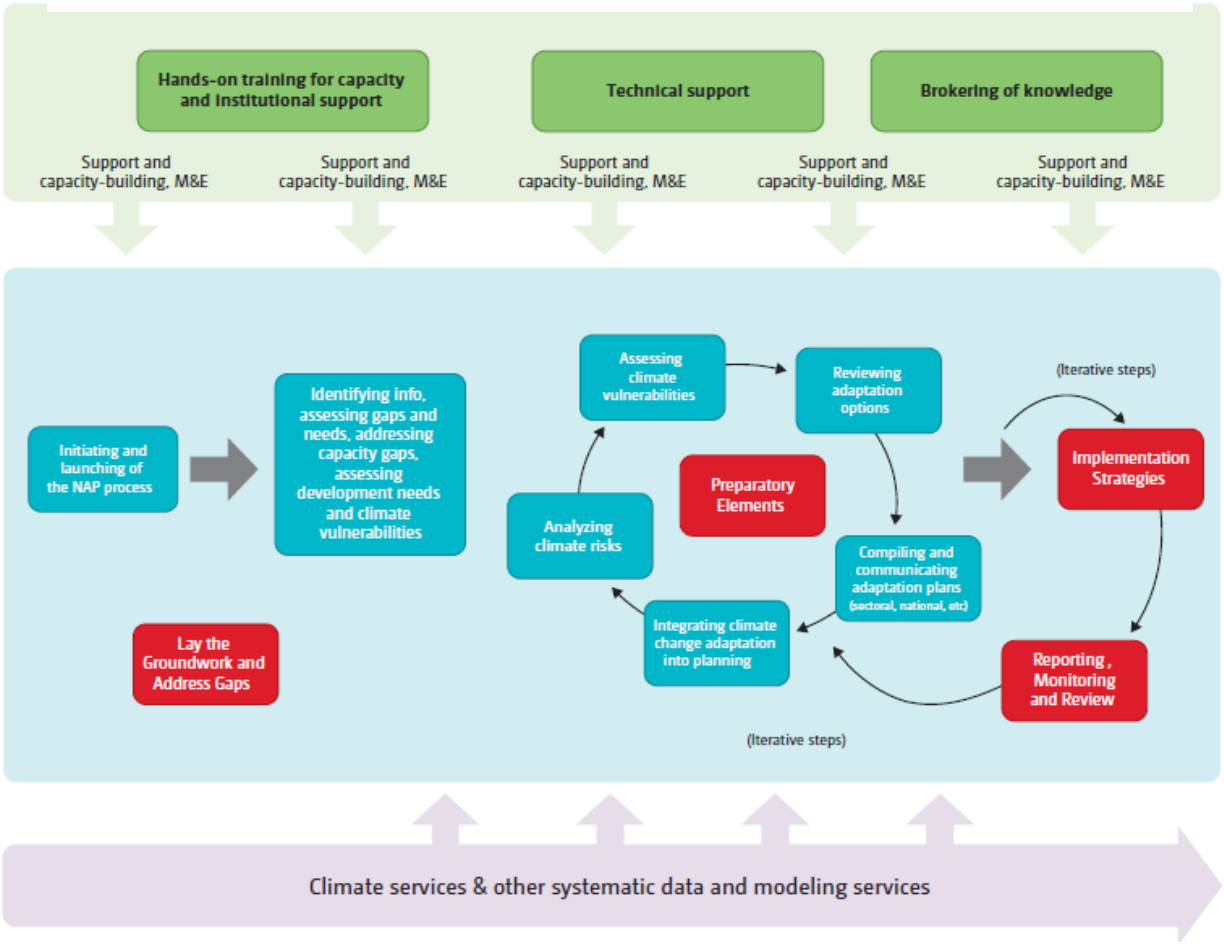
[3] *LEG - The Least Developed Countries Expert Group (LEG) was established in 2001 to support least developed countries (LDCs) in addressing the adverse impacts of climate change.*

institutions in Liberia can monitor and review the environment regularly and iteratively update the NAPs. Thus, the sectoral adaptation strategies in chapter 6 describe Liberia's medium- and long-term priorities for addressing climate change impacts.

As suggested by the UNFCCC and the LEG's Technical Guidelines, there are some principles that NAP processes should consider. The NAP process should follow a fully transparent, country-driven approach. This means that the methodologies for determining risks and vulnerabilities used in the NAP and the processes for identifying, prioritizing, and designing adaptation options, should be transparent and publicly available. This NAP process will be driven entirely by stakeholders within Liberia, and the NAP process will respond to the needs, priorities, and aspirations of the Liberian people. It will be consistent with Liberia's socioeconomic development trajectory.

Another critical principle is that the best available science guides the NAP process as appropriate, traditional, and indigenous knowledge. The NAP process is meant to inform *evidence-based* governance for adaptation (including planning, budgeting, and policy and legal development) and developing projects

Figure 1: NAP Process Diagram(LEG, 2012)



and programmes. Climate change involves dynamic processes and sometimes high levels of uncertainty about future trends and conditions. Therefore, creating a solid evidence base is an ongoing process that entails identifying and synthesizing existing data and information on the physical processes and impacts of climate change while making investments to improve data gathering, information management, and application to generate new data incorporated into planning strategies.

Therefore, the NAP process should also include mechanisms for effective coordination between various agencies within the national government and across government scales, from national to local. The NAP process should also encourage communication and coordination between government and non-government stakeholders and serve as an overall unifying framework for adaptation actions in Liberia that will help development partners identify and coordinate their support for Liberia's response to climate change.

1.3 Liberia's NAP process

Liberia joined the UNFCCC in 2002 and is a signatory to the 2002 Kyoto Protocol and the 2015 Paris Agreement. Liberia was also one of the first recipients of the Green Climate Fund (GCF) support for climate change to formulate its NAP. In 2017, the country completed its National Policy and Response Strategy on Climate Change to guide the country's efforts to mitigate the risks of climate change and reduce vulnerability.

In 2008, Liberia formulated its National Adaptation Programme of Action (NAPA) with technical support and funding from the Global Environment Facility (GEF) and United Nations Environment Programme (UNEP). The preparation of the NAPA was guided by existing strategies and policies, including the National Reconstruction and Development Plan (NRDP), the National Biodiversity and strategy action plan (NBSAP), and Sustainable Development Goals (SDGs; formerly the Millennium Development Goals). The NAPA indicated that Liberia was faced with climate variability and extreme events, which were having a negative impact on agriculture and socioeconomic development, leaving the rural poor at high risk.

The NAPA process identified several projects and urgent adaptation needs which included (1) agriculture adaptation, (2) national meteorological and hydrological monitoring, and (3) coastal defense. Based on these projects, through the EPA and the UNDP, the country initiated the NAP process in 2010 to address the alarming issues related to the climate and address human capacity. The original intent of the NAP process in Liberia was to reduce climate change vulnerability and strengthen institutional coordination for adaptation and expand on the existing knowledge base to scale up adaptation. Liberia's NAP process is intended to be an iterative process that coordinates the actions of government and non-government stakeholders at all levels, from sectoral line agencies at the national level down to villages and communities.

The **NAP Process** (this document) will serve as a blueprint to guide the overall process and provide structure. This NAP Process will be in effect for ten years (2020-2030), during which time there will be ongoing monitoring and evaluation, in approximately 2029, this first period of implementation will be reviewed, and a new framework will be developed to guide the period from 2031-2040.

Since establishing the NAP process to inform development policies, documents, and data gathering, Liberia has conducted vulnerability and risk assessments in several priority sectors, including agriculture, forestry, waste management, coastal zones, fisheries, and energy. Liberia has also engaged in ongoing efforts to build institutional and human capacities to support adaptation efforts.

In partnership with the United Nations Development Programme (UNDP), EPA has implemented the GCF-funded project NAP Readiness project to support the NAP process. The NAP project developed the capacity for climate change adaptation, mainstreaming gender considerations into Liberia's adaptation response, mainstreaming budget in climate change, and producing climate change vulnerability assessment in consultation with its main stakeholders. The road map provides a guideline for implementing the NAP process in Liberia and working in the short, medium, and long term. The objectives of the NAP process are:

i. to reduce vulnerability to the adverse impacts of climate change by building adaptive capacity and resilience; and,
ii. to facilitate the integration of climate change adaptation into fiscal, regulatory, and development policies, programs, and activities (UNFCCC, 2012).

The NAP also seeks to support climate change adaptation actions at the national and subnational levels (between line ministries and development partners) and accelerate strategic investments in climate-resilient development.

The GCF-funded projects advance the National Adaptation Plans (NAP) for medium-term investment planning in climate-sensitive sectors (i.e., agriculture, energy, waste management, forestry, and health) and coastal areas in Liberia. In addition, the project supports the Government of Liberia to advance its National Adaptation Plans in climate-sensitive sectors. The activities in this project focus on four outputs:

i. Strengthening institutional frameworks and coordination for implementation of the NAPs.
ii. Expansion of the knowledge base for scaling up adaptation.
iii. Building capacity for mainstreaming climate change adaptation into planning and budgeting processes; and
iv. systems formulation of financing mechanisms for scaling up adaptation (including public, private, national, and international)

In Liberia, the NAP process seeks to provide the enabling framework for the planning and implementing adaptation actions as enshrined in the National Climate Change Policy & Response Strategy (2018) and the Nationally Determined Contributions (NDCs, 2015), all done within the context of sustainable development. Improving adaptation planning through the NAP process will help build local adaptive capacity to address climate change (SDG13), which will reduce poverty (SDG1), thereby enhancing livelihood opportunities (SDG1) and improving gender equality (SDG5).

Parties to the UNFCCC have recognized the importance of involving women and men equally in UNFCCC processes and developing and implementing national climate policies that are gender responsive. Gender influences the type and magnitude of climate change impacts in all countries and those primarily reliant on natural resources for their livelihoods and who have the least capacity to respond to natural hazards, such as droughts, landslides, floods, and windstorms. In addition, women commonly face higher risks and more significant burdens from the impacts of climate change in the situation of poverty, and the majority of the world poor are women (UNFCCC, 2021).

Adaptation initiatives that do not take gender perspectives into account may unintentionally replicate general inequality. Therefore, mainstreaming gender into adaptation is critical to ensure climate change projects and policies (Habtezion, Scott, Wanjiru, & Bandiaky, 2012; Resurrection, 2019).

1.4. Goals and Objectives of Liberia's NAP Process

By 2030, the NAP process will augment Liberia's capacity to adapt and systematically reduce climate risks from a long-term perspective. Therefore, the specific objectives for the NAP document are to:

- Provide a framework and procedures for sharing of information of scientific, technical, and traditional knowledge on climate change risk management and develop capacity-building measures;
- coordinate sectors and related government and private land-use institutions on climate change risk management using awareness with a focus on the improvement of climate risk management actions; and
- Work with the priority sectors to identify and propose measures to promote adaptation to reduce climate change risk.

The table below presents the purposes of the NAP process broken down by specific objectives, listing the significant initiatives, agency responsible, impacts, and monitoring indicators.

Table 1: Description of the goals of the National Adaptation Plan broken down by specific objectives

Objective 1: Provide a framework and procedures for sharing information of scientific, technical, and traditional knowledge on climate change risk management and develop capacity-building measures	
Goal 1.1 **Develop and implement a strategy to enhance the quality of the climatic projections**	
Initiatives	1. Identify priority sectors and technologies for adaptation 2. Develop downscaled projections for potential future climate conditions based on the most recent global climate model (GCM) outputs
Indicator	Define the identification, dissemination, and progress on developing enhanced climate change technologies projections climate vulnerability based on the global climate models.
Outcomes	The goal will guide the country to expand on scientific knowledge and technical capabilities to produce climatic projections
Responsibility	EPA
Goal 1.2 **Develop a plan of action on technology needs for adaptation**	
Initiatives	1. Conduct mapping and evaluation of technology needs for adaptation through partnerships to determine national key player 2. Develop a roadmap to identify priority technologies.
Indicator	Progress of the technology of national adaptation plan
Outcomes	Climate technologies made available as inputs for decision making
Responsibility	EPA Partners (local and international)
Goal 1.3 **Prepare and deploy an online data integration system for monitoring, dissemination, and awareness-raising on the impacts of climate change**	
Initiatives	Share adaptation data on the Climate Change Knowledge Sharing Platform (CCKS) or the EKMS or consider an initiative: developing an information management architecture to disseminate climate change to various stakeholder groups effectively. The CCKS or EMKS is a web sharing platform managed by the EPA, launched with the focal person from line ministries and agencies, CSO, NGO (both national and international), and universities.
Indicator	Progress reports on the development and integration of climate change impact data will be visible to line ministries, agencies, and universities for research purposes.
Outcomes	1. foster the availability to produce high-quality data on the impacts of climate change 2. foster dissemination of information and knowledge relating to impacts of climate change 3. expand the capacity to respond to impacts of climate change

Objective 1: Provide a framework and procedures for sharing information of scientific, technical, and traditional knowledge on climate change risk management and develop capacity-building measures	
	4. Stimulate national production of knowledge 5. Use of data for research and academic purposes
Responsibility	EPA and Partners

Objective 2: Coordination and cooperation among public agencies and society	
Goal 2.1. **Formulate a capacity-building strategy for adaptation for various target public agencies, CSOs, NGOs**	
Initiatives	1. Conduct awareness building and public mobilization activities 2. Conduct a capacity building program for professionals and active leaders in strategic areas and among the more vulnerable group 3. Promote the production and dissemination of knowledge on adaptation by strengthening institution and research
Indicator	1. Liberians will be aware of climate change through the public mobilization activities 2. The number of professionals trained for climate change adaptation increased
Outcomes	1. Development of capacities for adaptation, increase mobilization and awareness on the theme of climate change 2. Greater support for effective implementation of public policies for adaptation
Responsibility	EPA and Partners
Goal 2.2. **Deployment of NAP monitoring and evaluation (M & E) system**	
Initiatives	1. M & E system for adaptation integrated into the monitoring system 2. Include the actions of adaptation of GoL, sectors
Indicator	Progress in the development and implementation of the monitoring system.
Outcomes	1. Updated information on progress and performance of the NAP and its sectoral strategies 2. Provide transparency for the deployment of adaptation policies and enable the sharing of information among government bodies and CSO
Responsibility	EPA, CSO, and Partners
Goal 2.3. **Drafting and initiation of adaptation strategies**	
Initiatives	1. Form an inter-governmental working group 2. Support formulation of an adaptation strategy, with inputs of knowledge, methodologies, and training 3. Prepare the strategy
Indicator	1. Document strategy for adaptation policies

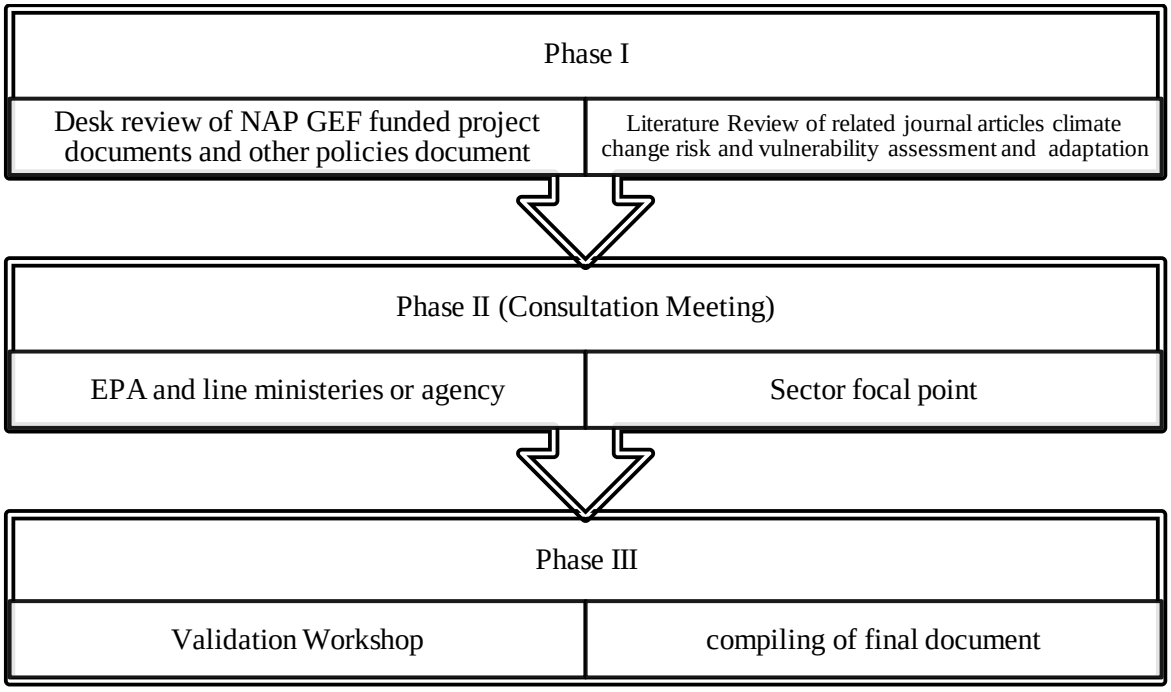
Objective 2: Coordination and cooperation among public agencies and society	
	2. Number of governmental institutions and agencies engaged
Outcomes	Increased mobilization and awareness of the theme among governmental institutions and agencies to Increase capacity
Responsibility	EPA, CSO, government institution

Objective 3: Identify and propose measures to promote adaptation to and reduction of climate risk	
Goal 3.1. **Develop and deploy sectoral risk vulnerability assessment**	
Initiatives	1. Develop sectoral risk and vulnerability monitoring methodology for each sector 2. Enhance methods for modeling and estimation of climate change risk
Indicator	Enhance methods for modeling and estimation of climate change
Outcomes	1. Assist with planning of exports 2. Ensure appropriate and effective investment of resources
Responsibility	EPA and key sectors
Goal 3.2. **Establish a center for climatic intelligence for all sectors at the EPA**	
Initiatives	1. Develop a support system for spatial and integrated analysis 2. Create the climate intelligence center for Agriculture communication and early-warning
Indicator	1. Number of systems and models made available 2. Climate change center for agriculture communication and early warning system
Outcomes	1. Application of climate risk assessment in planning actions 2. Ensure appropriate and adequate resources for the adaptation of agriculture to climate change 3. Improve the predictability of agriculture insurance planning
Responsibility	EPA

1.5. Approach

The Environmental Protection Agency led the NAP process development. The consultants worked with the EPA in the development of this document. The NAP process document is in effect from 2020-2030, supporting Liberia Vision 2030 policy document.

Figure 2: Summary Approach for formulating NAP process



The approach used in gathering the information for this document involved three interlinked phases.

In **Phase I**, an extensive desk-based review of the past NAP project document and policy document, the National Climate Change Policy, and related pertinent literature were conducted. This step included a stakeholder meeting and sector expert consultative meeting. The stakeholders and the sector expert consultative were identified by the NAP project management team at the UNDP.

Phase II involved consultations with critical stakeholders for the priority sectors based on a stakeholder mapping exercise conducted by the NAP projects manager and EPA's management team. Stakeholder consultations included a broad range of participants. Experts with comprehensive knowledge and experience with climate change processes and adaptation in Liberia were present. Also present were representatives from government institutions, non-government organizations, civil society organizations, and academic institutions. The consultations provided an opportunity to explore challenges and opportunities within existing mandates and to map additional stakeholders. Then, a plan to engage different stakeholders in planning and implementing adaptation was discussed. All consulted stakeholders have longstanding and comprehensive expertise in climate change adaptation and other relevant issues in Liberia. This phase also included working with relevant technical partners, institutions, and experts to identify broader climate change issues.

During Phase II, published journals and websites were visited to have information on Liberia's climate change historical and future trends. The objective was to define the change in Liberia's temperature (global warming) and precipitation, focusing on the historical events and future or projections up to 2055.

Phase III involved a national validation workshop conducted at the University of Liberia Graduate School, located on the Capitol Hill campus. A total of 15 experts and stakeholders from different sectors and agencies were present. These stakeholders reviewed the draft NAP Process and provided input and feedback, subsequently incorporated into the final NAP Process document.

CHAPTER 2 LEGAL and POLICY FRAMEWORKS

2.1 Introduction

This chapter describes how the NAP Process will align with the existing legal and policy framework in Liberia. To be effective, Liberia's adaptation response to climate change must be integrated into the country's overall approach to encouraging socioeconomic development and responsible stewardship of natural resources. This chapter describes the NAP process's linkages to Liberia's environmental management laws and policies and existing policies and strategies related to climate change. The chapter also describes Liberia's economic development trajectory and how the NAP process will support objectives in the Vision 2030 and Pro-Poor Agenda for Prosperity & Development.

Adaptation is a process by which individuals, communities, and countries seek to cope with the consequences of climate change. The process of adaptation is not new; the idea of incorporating future climate risk into policymaking is. However, while our understanding of climate change and its potential impacts has become clearer, the availability of practical guidance on adaptation has not kept pace. The policies are intended to help provide the rapidly evolving process of adaptation policymaking with a much-needed roadmap. Ultimately, the policy's purpose is to support adaptation processes to protect – and enhance – human well-being in the face of climate change.

The information in this chapter is relevant to government and non-government stakeholders alike. It should contribute to policy formulation, adaptation project design, and strategic processes for businesses, non-governmental organizations, and development partners.

2.2. NAP linkages to existing climate change and disaster risk reduction policy framework.

The below table lays out the linkages between the NAP process and existing climate change and disaster risk reduction policies, strategies, plans, and frameworks.

2.2.1 Critical Adaptation Policy

National Policy and Law	Policy or Law summary	Policy on Adaptation	NAP-Policy Link
NPRSCC, 2018	This National Climate Change Policy and Response Strategy (NPRSCC, 2018) was developed to guide national response measures in addressing climate change. The strategy further guides integrating climate change issues into national development planning processes at national, county, district, and local levels for effective coordination. It also outlines policies for adaptation and mitigation in crucial sectors in the country.	Section 8 discusses the adaptation, mitigation policies, and Strategies under sectors identified as key to the climate change setting of the Republic of Liberia. Enabling pillars or building blocks, which are critical for realizing the policies and strategies implementation, are presented in section 9. Pillar III on capacity building and knowledge management	The NAP is linked to NPRSCC by implementing the adaptation strategies under section 8 of the policy. The NAP also focuses on capacity development and, therefore, link to Pillar III of the NPRSCC, 2018. The NAP process will facilitate the implementation of the NPRSCC to guide national response measures in addressing climate change.
INC, 2013	The Initial National Communication to the UNFCCC was developed to conduct a national-level analysis of the technologies and practices that can either reduce the sources of GHG emissions (reduction) and/or enhance their sinks (uptake) while supporting sustainable development. The INC provides strategic recommendations for increasing the implementation of GHG mitigation technologies in Liberia.	Section 4 discusses climate change vulnerability and adaptation recognizes that gender is a vital element when considering actions to mitigate and adapt to climate change. Section 5.2.3. describes a variety of adaptation and mitigation technologies for the agriculture, energy, forestry, and waste management sectors Section 10 describes capacity building needs. These include strengthening the appropriate policy, regulatory, and institutional frameworks to identify and remove barriers to capacity building and create a supportive backup for enactment	The INC is linked to the NAP because it emphasizes incorporating gender considerations into adaptation planning processes. Section 5.2.3 links to the INC to the NAP as this section identifies priority adaptation actions and technologies. The NAP and NAP processes will serve as an implementation mechanism for these priorities. The NAP process will achieve this by facilitating integrating these priorities into sectoral plans and identifying additional financial resources (e.g., climate financiers) to support implementation.

2.2.1 Critical Adaptation Policy

National Policy and Law	Policy or Law summary	Policy on Adaptation	NAP-Policy Link
		and implementation. In addition, strengthening the EPA's technical and human resources capacity and collaborating stakeholder institutions to implement the UNFCCC effectively and efficiently are also recognized as priorities.	Section 10 links the INC and the NAP through the adaptive capacity of personnel from the EPA and line ministries in the reduction of GHG emission "The NAP and NAP process will also facilitate the implementation of the capacity-building measures recommended in section 10 of the INC."
NDMP, 2012	This National Disaster Management Policy (NDMP, 2012) seeks: 1. To create a foundation for developing a practical and functional legal, institutional framework and good governance for disaster risk management (DRM). 2. To provide the basis for sound DRM national and local organization, capacity enhancement, and clear roles and responsibilities. 3. To provide overall direction for integrating disaster risk reduction into development, recovery, and humanitarian response policy and plans.	Section 5 on the critical priority policy areas integrate the NDMP in at the local, national, and sectoral policies to ensure better cooperation, coordination, and partnership "The NDMP highlights the importance of integrating climate risk management into DRM. The Policy also establishes a mandate for the government to 'ensure complementarity between DRM and climate change initiatives (p28) and directs government stakeholders to link disaster risk management and climate change adaptation activities throughout the country".	Section 5 links the NDMP and the NAP because the NAP strategies policies identify and appraise adaptation strategies at the sectoral, sub-national, and national levels defined in section 5 of the NDMP. Developing and recommending the enactment of an environmental, industrial, and agricultural, and gender-sensitive NDM Act provided a clear link to climate change adaptation and climate risk management. "The institutional arrangements established for NAP formulation and implementation will incorporate a formalized coordination mechanism with Liberia's disaster risk management planning system. This

2.2.1 Critical Adaptation Policy

National Policy and Law	Policy or Law summary	Policy on Adaptation	NAP-Policy Link
	4. To contribute to national risk management applications for sustainable national development; and 5. To strengthen disaster preparedness for effective emergency and recovery response.		coordination will help to ensure that the coordination mandate in the NDMP is met. In addition, given the significant overlaps between disaster risk reduction and climate change adaptation, the NAP process will identify adaptation actions that provide DRM co-benefits.
NAPA, 2008	National Adaptation Programme of Action (NAPA) provides a process for Least Developed Countries (LDCs) to identify priority activities that respond to their urgent and immediate needs to adapt to climate change – those for which further delay would increase vulnerability and costs at a later stage. Adaptation to increasing climate variability and climate change is a critical topic in Liberia. While some national coping strategies have already been developed to deal with extreme climatic phenomena, they are only a beginning. As such, the NAPA process has allowed Liberia to systematically and in concert with a comprehensive set of stakeholders the type of measures that could increase the capacity of vulnerable communities to cope with the urgent and immediate needs	"The Environmental Protection Agency prepared Liberia's NAPA to identify the most urgent adaptation needs. The NAPA provided an initial analysis of climate vulnerabilities and the socio-economic conditions that make people more sensitive to climate change impacts. The NAPA's recommendations included policy-level actions as well as project-level initiatives. The GoL has made significant progress on addressing the NAPA's priorities, including the GEF-funded Coastal Defense Project (2012-2015), the GEF-funded Climate Change Adaptation Agriculture Project (2012-2015), and the GEF-funded Climate Information for Resilient Development/Early Warning System Project (2013-2018). However, these projects have limited budgets and scopes	"The NAP Process has included a stock take of NAPA implementation progress to identify achievements, lessons learned, and additional needs. The NAP process will build on the experience of the NAPA and will identify opportunities to scale up the NAPA's successful interventions. In addition, the NAP process will incorporate the urgent adaptation needs identified in the NAPA into its policy priorities and lists of prioritized adaptation actions".

2.2.1 Critical Adaptation Policy

National Policy and Law	Policy or Law summary	Policy on Adaptation	NAP-Policy Link
	associated with increasing climatic volatility and future climate change.	and require further scaling up to the national level. In addition, limited progress has been made on other NAPA priorities, including transportation, hydropower, and health.	
EPML, 2002	The Environmental Protection and Management Law (EPML) of Liberia establishes a legal framework for the sustainable development, management, and protection of the environment by the Environment Protection Agency in partnership with regulatory Ministries and organizations and a close and responsive relationship with the people of Liberia; and to provide high-quality information and advice on the state of the environment and for matters connected therewith. The EMPL has several principles and objectives to include but not limited to the following: The principle of sustainable development; The precautionary principle, the polluter - pays principle, the principle of inter-generational equity, the principle of public participation, the principle of international cooperation in the management of environmental resources shared by two or more states; and Other	The Act creating the Agency provides the legal mandates and authority to manage, coordinate, monitor, and supervise in consultation with relevant line Ministries, Agencies and organizations, and other relevant stakeholders for the protection of the environment and sustainable use of natural resources which are defined in the adaptation strategies of the NAP Process. The act details the functions of the EPA from the Policy Council to environmental inspectors. The Act also clearly explains the entire environmental impact assessment (EIA) process in its totality.	The NAP is linked to the EPML through the Environmental Impact Assessment (EIA) under section 5, part III. Since the EIA collects data before and after, it is critical to the NAP, especially in monitoring and evaluation. Therefore, the implementation of this NAP is linked to the EPML to protect the environment, thereby reducing climate risk and vulnerability. The EPML will also provide policy empowerment to the committee on the monitoring and evaluation as stated under section 25 of the law.

2.2.1 Critical Adaptation Policy

National Policy and Law	Policy or Law summary	Policy on Adaptation	NAP-Policy Link
	principles of natural resources and environmental management.		
NDC, 2015	Initial Nationally determined contributions (NDCs) are at the heart of the Paris Agreement and achieve these long-term goals. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. The Paris Agreement (Article 4, paragraph 2) requires each Party to prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve. In addition, parties shall pursue domestic mitigation measures to achieve the objectives of such contributions.	The Nationally Determined Contribution (NDC) communicates Liberia's contributions to meeting the goals of the Paris Agreement. The NAP process can help to identify NDC adaptation goals and translate them into action or strategy. Both the NAP and NDC are complementary processes and should ideally be aligned to strengthen national climate change adaptation. According to Article 2.9 of the Paris Agreement, all parties shall, as appropriate, engage in the adaptation planning process.	The links between the NAP and NDC processes largely depend on timing and/or sequencing. The NAP and NAP Process implement define the adaptation targets included the NDC. This NAP process offers a vehicle for implementing adaptation commitments included the NDC. Since NDCs are updated every five years, this NAP and NAP Process can potentially regularly revisit the priorities included in the NAP, if appropriate. As NDCs are externally facing pledges, the adaptation component of NDCs may help raise the profile and garner further support for the NAP process. Ideally, the NAP process and the adaptation component of NDCs will be aligned

2.3. NAP linkages to national economic and social development frameworks

2.3.1. Vision 2030

Vision 2030 seeks to build Liberia a new for succeeding generations by improving the country's economy. Chapter II of Vision 2030 focuses on four broad categories: demography, economy, social structures, and governance. These four categories are fundamental to every citizen's economic growth and social empowerment, and Vision 2030 describes goals concerning each of them. However, the achievement of these goals could be challenged by an unsustainable environment and changing climatic conditions. Therefore, four categories are aligned with the adaptation strategies and the socioeconomic profile of the NAP Process. Liberia is facing the challenge of environmental depletion and degradation at quite a fast pace. If current trends persist, water, land, air, and biodiversity resources will likely be seriously affected. In addition, Liberia's trend analysis shows that the country economy could be involved from the increase in frequency and intensity of extreme weather as associated with flooding and drought (feature); both flooding and drought are related to the quality of water resources, agriculture activities, emerging and re-emerging diseases. Therefore, growth of Liberia's economy relies on the development and implementation of an adaptation policy document that will improve Liberia's GDP.

Therefore, the NAP implementation, especially the agriculture, forestry, fisheries, energy, coastal areas, and waste management strategies, will support Liberia's Vision 2030 policy on the economic growth of every Liberia and align to the four categories in chapter II.

2.3.2. Agenda for Transformation (AFT)

The AFT, the country's national development document, recognizes climate change adaptation under Pillar V as a cross-cutting issue. Pillar V is aligned to the NAP Process because it is cut across climate change. The AFT is designed to serve as a five-year (2012-2017) agenda based on Liberia's poverty reduction strategy (PRS), which raised Liberia from post-conflict emergency reconstruction and positioned its future growth. The future growth relies on developing the country's economy, which is based on agriculture, forestry, fisheries, and extractive industries (e.g., timber, rubber, mining).

Pillar III on human development is relevant for the NAP Process related to the development of adaptive capacity. **Adaptive capacity** will be enhanced by reducing non-climatic stresses about factors such as pollution and resource exploitation; the promotion of sustainable development is thus likely to **improve** the **adaptive capacity** of ecosystems.

Pillar III also discusses education. Education is pivotal to the NAP Process as it will be applied for awareness and to educate local stakeholders. Therefore, the implementation of the NAP relies on the available personnel with requisite skills from EPA and other line ministries. Therefore, human development

is fundamental to this NAP Process. Thus, the NAP Process is linked with the Agenda for Transformation Pillars III and V.

The NAP Process and the Agenda for Transformation (AFT) are linked through Section 12.5 on the Environment. The AFT on the extractive industries is concerned with the effective management of the environment to ensure sustainable livelihood and economy. However, the NAP process also focuses on sustaining the environment through adaptation strategies that could improve the unstainable use of the environment when implemented. Under the AFT, environmental awareness training and educational program link the specific objectives of the NAP process. The AFT explains Liberia's challenges, including forest deforestation, soil erosion, loss of biodiversity, coastal erosion, and pollution of coastal waters, which are addressed in the NAP adaptation strategies. In addition, strengthen ownership and participation of communities in decentralizing natural resource management and decision-making on the AFT's environmental issues could be linked to the NAP process subnational sector.

2.3.3. PAPD

The Pro-Poor Agenda for Prosperity and Development from 2018 to 2023 (PAPD) is the current document guiding Liberia's development strategy. One of the two goals of the PAPD is to provide greater income security to an additional one million Liberians and reduce absolute poverty by 23 percent across 5 out of 6 regions--through sustained and inclusive economic growth driven by scaled-up investments in agriculture, infrastructure in human resource development, and social protection. The agriculture sector is seen as a driver of food self-sufficiency, income security, and economic transformation at the regional and national levels. It is expected that by 2013, the PAPD will achieve a more competitive, productive, and diversified agricultural sector in Liberia that promotes value chains, agricultural processing, and marketing for food self-sufficiency, increased exports, job creation, and livelihood opportunities (GoL 2018). More specifically, the PAPD will promote rice, cassava, and vegetables using new and appropriate technologies to boost the agricultural sector as a significant source of Liberians' foreign exchange and livelihood. In addition, since the agriculture sector is among those most vulnerable to climate change, a practical approach to climate change adaptation is critical to ensuring that the country can achieve these goals.

The NAP process is linked to PAPD through the implementation of **Pillar One** (Power to the People). The Management of the natural resources as indicated in the PAPD is implemented on the adaptation strategies of this NAP. The adaptation strategies discuss the vulnerability of Liberia's natural resources and provide strategies to sustain resources.

2.3.4. National Gender Policy

The impact of climate change is not just an economic paradigm but also a social one. It has a gender dimension that affects men and women differently due to their social responsibilities, roles, power relations, culturally constructed roles, and relations, considering their lack of leadership and limited access to and control over resources. Therefore, it is paramount that the NAP process is conducted in compliance with the National Gender Policy (NGP). Regarding gender considerations, the policy guarantees the rights of women to access justice. The Constitution of Liberia guarantees these rights. In line with the Constitution, the NGP will focus on the following priority issues: socio-cultural discrimination against women and girls; gender-based violence, high maternal and child mortality and morbidity rates; low awareness about rights among men and women; gender inequality; low literacy among women and high levels of fertility.

The first NAP has been formulated to be consistent with these existing directives to promote equality between women and men. To ensure that gender considerations are appropriately mainstreamed into the NAP process in 2019, GoL, with support from UNDP, conducted a study on gender and social impacts relating to climate change. This study indicated that intense rainfall, shorter seasons, and strong wind all increase vulnerability associated with climate change for both genders. However, in terms of water scarcity, women are at high risk and are vulnerable to climate change impacts, in part because the wells they use for household water are increasingly likely to run dry (UNDP-Liberia, 2019). In addition, a GEF-funded project in five counties in Liberia found that there is a high degree of vulnerability among women. Near all women in the project area have observed a decrease in their incomes from agriculture and fishing activities, making it more difficult to meet household expenditure needs and send children to school. Moreover, while all women are vulnerable, some are more vulnerable than others, including widows and single mothers. (UNDP-Liberia, 2019).

Additionally, the NAP process will be carried out in compliance with Liberia's commitments to various international instruments such as the Universal Declaration of Human Rights and the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW), and Sustainable Development Goal #5, Gender Equality as well as mainstreaming gender in climate change. Liberia's National Gender Policy (2009) and the UNFCCC highlight the need to address gender inequality and a complete gender integration programme. This is particularly vital within the realm of climate change, given the disparate impact it has on women (Mai *et al.*, 2018). To ensure a gender-responsive approach, the NAP will examine and address the gender norms, roles, and inequalities; and vigorously promote gender equality.

This means that gender will be considered at all stages of the NAP implementation, and monitoring and evaluation, and at different levels of decision-making processes. To monitor progress and capture lessons learned, technical M&E parameters will be proposed and used to determine whether gender is adequately reflected in climate change adaptation plans, programs, and projects. Hence the NAP process will draw on international best practices for mainstreaming gender and social equity considerations into public policy and implementation.

The NAP process will have the vital co-benefit of serving as a demonstration and example for other public policy processes in Liberia. Therefore, the NAP process implements strategies, pillars, and relevant information relating to climate change adaptation from laws and policy frameworks developed to reduce climate change impact and improve vulnerability.

CHAPTER 3. SOCIO-ECONOMIC PROFILE

3.1. Introduction

Socioeconomic development comprises many factors like population, economic activity, urbanization, education, social equality, consumption patterns, lifestyles, and institutions. Climate change and socioeconomic development are deeply intertwined. Social and economic activities and processes are among the primary determinants of vulnerability to the impacts of climate change.

Recent literature illustrates the economic and social challenges facing cities globally due to climate change, including energy shortages, damaged infrastructure, and food and water scarcity. These changes are interrelated. Economic losses associated with climate change make it difficult for residents to maintain their livelihoods and exacerbate social issues, including poverty and hunger. Simultaneously, some demographic and socioeconomic characteristics of cities can make them especially vulnerable to climate change. The success of climate change adaptation strategies depends mainly on social economics. Therefore, exposures in a country may often be more significant among populations with low socioeconomic status. (Gasper, Blohm, & Matthias, 2011; IPCC, 2014; Roiko et al., 2021).

This chapter describes some of Liberia's most critical social and economic conditions and processes as the relationship to climate change.

3.2. Socioeconomic

Climate change impact and socioeconomic conditions are inseparable. Social and economic activities are the primary driver of climate change. Climate change threatens global sustainability, especially in rural communities of developing countries. In Liberia, severe impacts of climate change have become evident in the recent past. Large-scale floods have caused massive damages to properties. Understanding the perspective of local communities regarding climate change adaptation strategies is pivotal to effective policymaking. For example, consider the neighborhood of West Point in Monrovia. The people who live there are among the most vulnerable to climate change. They are vulnerable because of where they live, but social and economic conditions and processes push them into that area and make them less able to adapt.

While human social-economic activity leads to climate change, the latter also affects the former; social economic and climate systems have considerable interactions. Studies have shown that greater levels of climate change occur with a more significant socioeconomic impact on the global levels. Social equality can be described in terms of gender, age, race, ethnicity, etc. For example, Liberia has a very young population (Figure 5), making the country vulnerable to climate change.

3.3. Population

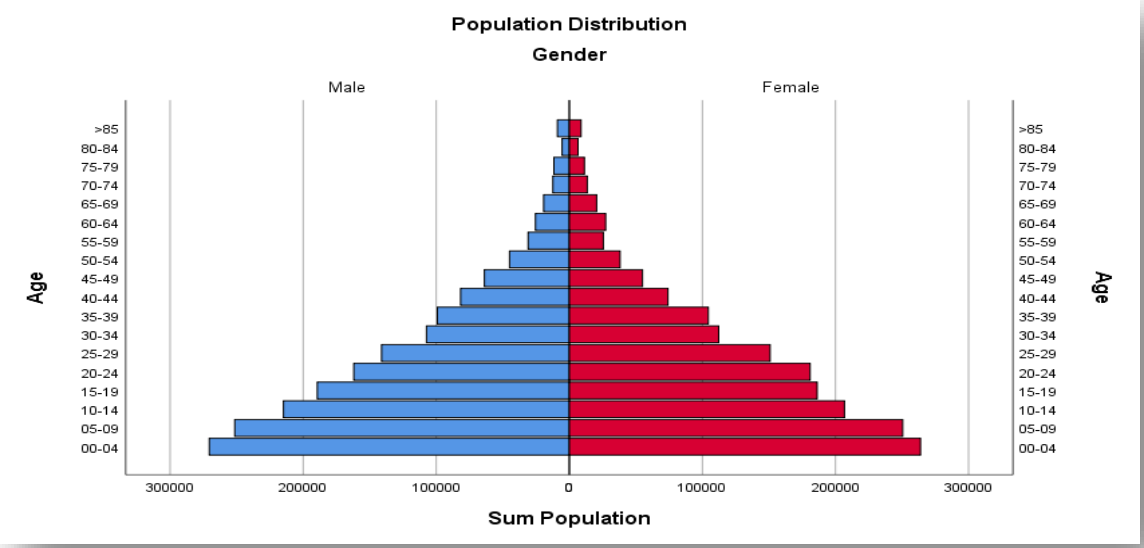
The adaptation is critical because of investment. Investment targeting the young population needs to address climate for two reasons: (1) the success and sustainability of efforts to create jobs will depend on the future climate, and (2) the young population will bear the costs of failure throughout their lifetimes (Beccio, 2021). Therefore, the development of climate adaptation and implementation could improve the lifestyle of the young population in the future.

Older people are physically challenged and more vulnerable to extreme heat, so that population aging could exacerbate increases in heat-stress mortality brought on by climate change. Higher temperatures also exacerbate outdoor air pollution such as ozone, disproportionately affecting older people (PRB, 2001).

According to 2008, the Liberia Institute of Statistic and Geo-Information Services (LISGIS) National Housing Population Census results show the country's population to be 3.5 million. However, more recent estimates indicate that the population may be between 4.2 million (LISGIS, 2017a) and 4.6 million (WHO 2016), with approximately 48.9% male and 51.1% female. The life expectancy at birth (WHO, 2016) in the male to female ratio is 62years/64years.

Liberia's population pyramid demonstrates that most of the population is young. The structure of the population pyramid is essential for several reasons. First, the National Adaptation Plan process is systematically necessary because Liberia has a lot of young people. Second, a big priority of the country will have to be investments that lead to job creation. Some of these jobs will be in the primary sector, as pointed out in the vulnerability section. Hence, planning and investments in that sector need to ensure that the assets and the expansion are sustainable and resilient to climate change. At the same time, a young population means that people will eventually want houses, families, etc., so they need to have places to grow where they are safe from the shocks and stresses of climate change. So unlike countries that are NOT growing with population, Liberia has spatial planning challenges in the future. Therefore, the EPA must incorporate climate change in town and regional planning processes.

Figure 3: Population Distribution by age and gender (LISGIS, 2018)



3.3.1. Poverty

Poverty is a significant background factor contributing to climate change vulnerability in Liberia. More than half of the population lives in poverty, with almost 40% of the population experiencing food poverty (LISGIS 2017). In addition, the rate of extreme poverty in rural areas is significantly higher than in urban areas, though there are significant concentrations of poverty in rural areas. There are also noticeable regional differences in extreme poverty, with the highest levels affecting River Gee and Maryland counties in the country's southeastern part.

Climate Change is as much a challenge for poverty reduction, growth, and development as it is a global environmental issue. Previous studies indicate that in high fertility settings, fertility decline facilitates economic growth and poverty reduction. It also reduces the pressure on livelihoods and frees resources that can be used to cope with climate change (Das Gupta, 2014; World_Bank, Mearns, & Norton, 2013). **On the other hand, climate change** threatens the cleanliness of our air, depletes our water sources, and limits our food supply. It disrupts livelihoods, forces families from their homes, and pushes **people** into **poverty**[4]. A study suggests that the best way to address **climate change** impacts the **poor** is by integrating adaptation responses into development planning[5].

[4] https://www.mercycorps.org/blog/climate-change-poverty
[5] *Poverty and Climate Change: Reducing the Vulnerability of the Poor through Adaptation; http://www.oecd.org/env/cc/2502872.pdf*

3.3.2. Education

Education was recognized to empower, inform, and motivate those engaged, the wider community, and the government to change climate change[6].

Literacy rates are higher among urban dwellers (78.1%) than those living in rural areas (47%). Literacy rates are also far higher for men (75%) than women (52%) between the ages of 15-49 years. Approximately 16% of women and 27% of men between the ages of 15-49 ages have completed senior secondary or high school (LISGIS, 2021). The literacy rate has been crucial in social development because it indicates the level of formal learning among the population and reduces poverty and climate change adaptation. In addition, more literate people tend to have a greater awareness of climate change and access to information about climate risks and adaptation strategies, which increases their individual and household adaptive capacity.

The LISGIS 2017 further indicates that 75.7% of males and 51.2% of females attend formal education. LISGIS defines formal education as attending a primary school, secondary school, or university. However,

Figure 4: Liberia Population by county (LISGIS, 2017)

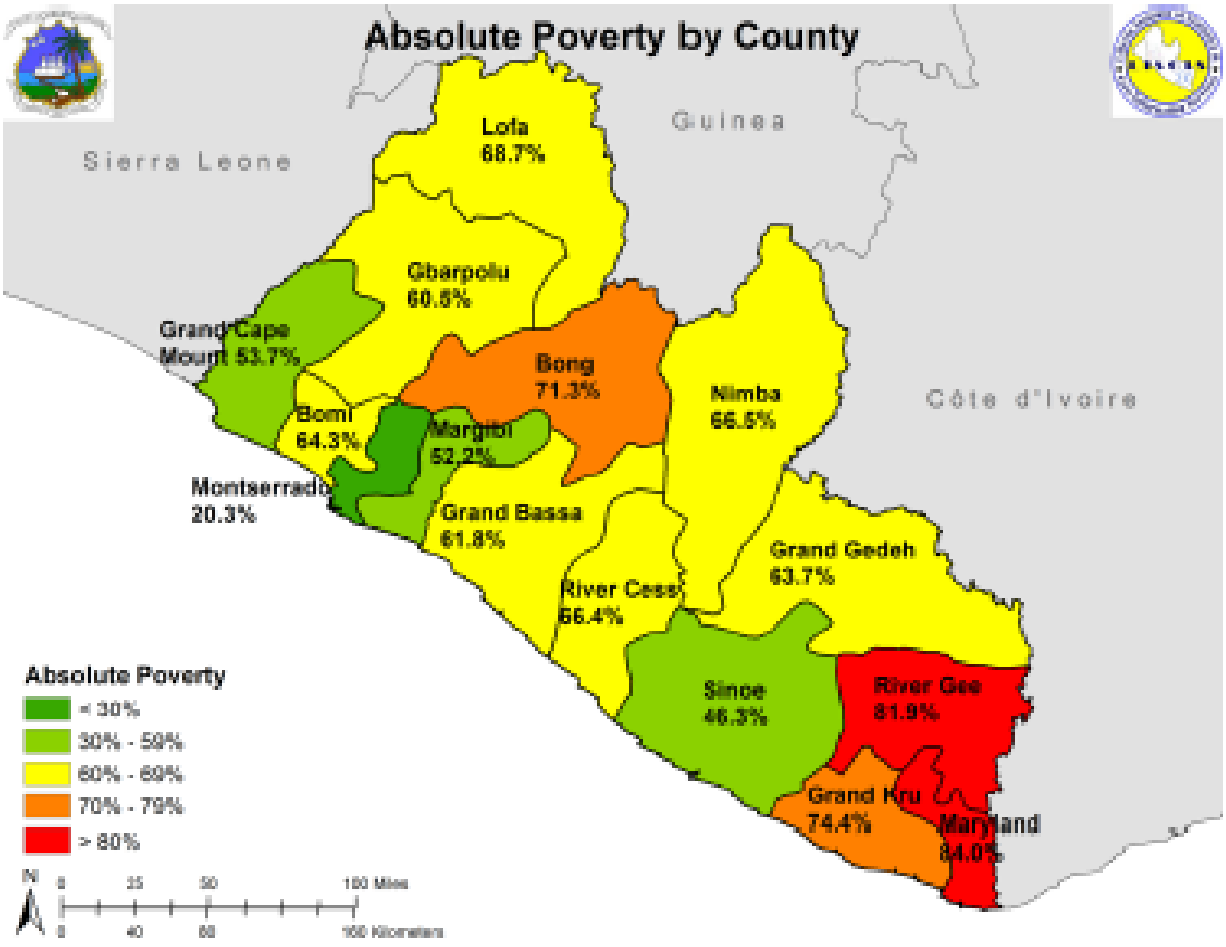
Liberia's adaptive capacity could be hindered by its poverty rate distribution. Adaptation depends significantly on the adaptive capacity or adaptability of an affected system, region, or community to cope with the impacts and risks of climate change. Their socio-economic and educational characteristics

[6] *https://www.thecommonwealth-educationhub.net/the-role-of-education-in-propelling-climate-action/*

determine the adaptive capacity of communities. Enhancement of adaptive capacity represents a practical means of coping with changes and uncertainties in climate, including variability and extremes. In this way, the enhancement of adaptive capacity reduces vulnerabilities and promotes sustainable development. The capacity to adapt varies considerably among regions and socioeconomic groups in Liberia.

Enhancement of adaptive capacity in the country is necessary for reducing vulnerability, particularly for most of our vulnerable regions or sectors as estimated from the vulnerability and assessment project and socioeconomic groups. Activities required for the enhancement of adaptive capacity are essentially equivalent to those promoting sustainable development. Climate adaptation and equity goals can be jointly pursued by initiatives that promote the welfare of the poorest members of society—for example, by improving food security through smart agriculture practices and facilitating access to Liberia ONE Health system. Development decisions, activities, and programs play essential roles in modifying the adaptive capacity of communities and regions, yet they tend not to consider risks associated with climate variability and change.

Figure 5: Absolute poverty rate at the county level (LISGIS,

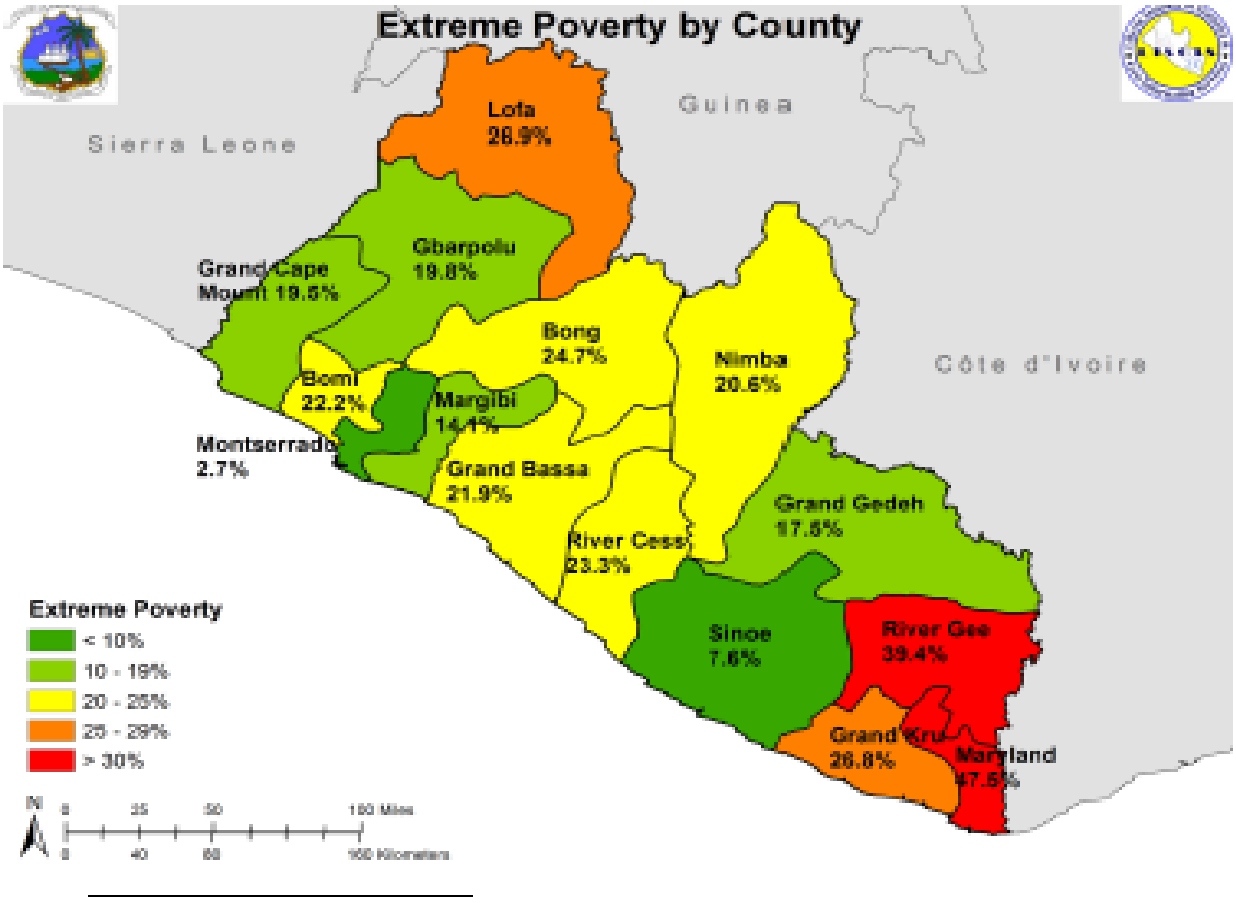


Finally, education is an essential element of the global response to climate change. It helps people understand and address the impact of global warming, increases climate literacy" among young people, encourages changes in their attitudes and behavior, and helps them adapt to climate change-related trends[7].

3.3.3. Employment

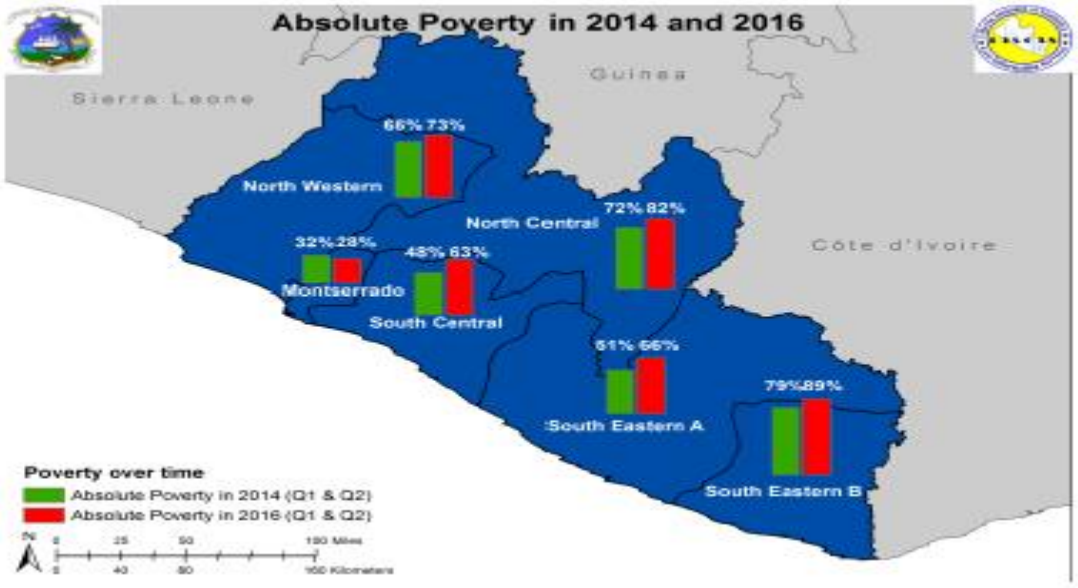
In developing countries such as Liberia, unemployment is not the best indicator of the labor market since most of the population must find a means to earn income. Thus, the vulnerable and informal employment rates provide a more insightful picture. While outright unemployment is low, underemployment rates are very high at 79.9% and 79.5%, respectively. According to LISGIS, the

Figure 6: Extreme poverty in Liberia by county



[7] *https://en.unesco.org/themes/addressing-climate-change/climate-change-education-and-awareness*

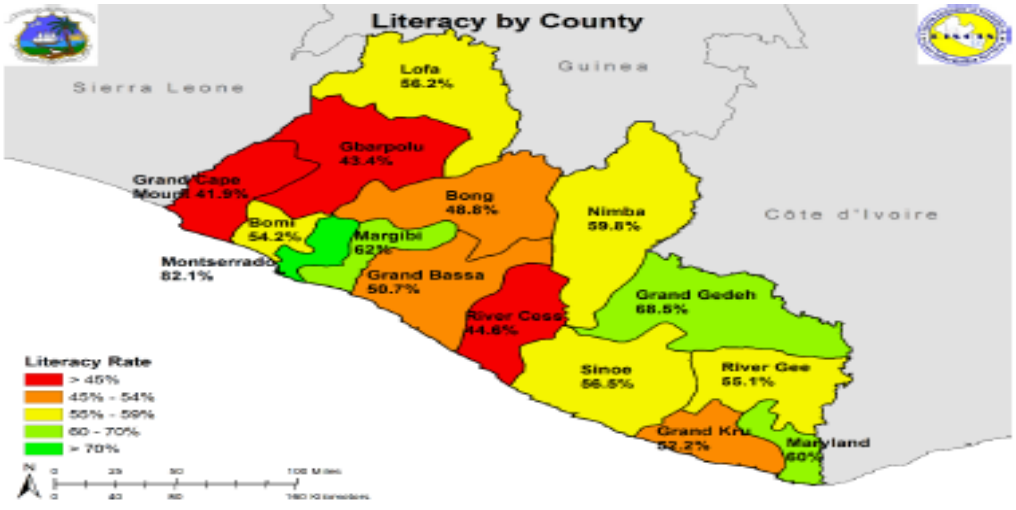
Figure 7: Absolute Poverty in 2014 and 2016 by Region (LISGIS, 2017)



employment rate in Liberia is divided into three categories: (1) informal employment, (2) vulnerable employment, and (3) unemployment (LISGIS, 2017).

Changes in the climate will have an enormous impact on employment and the labor market in general, especially in developing countries. The world of work is intimately related to the natural environment. Climate change threatens the provision of many of these vital ecosystem services and endangers the jobs that depend on them. The risks and hazards associated with environmental degradation tend to affect vulnerable workers the most. Adaptation measures can lead to employment gains and prevent job losses (ILO, 2018).

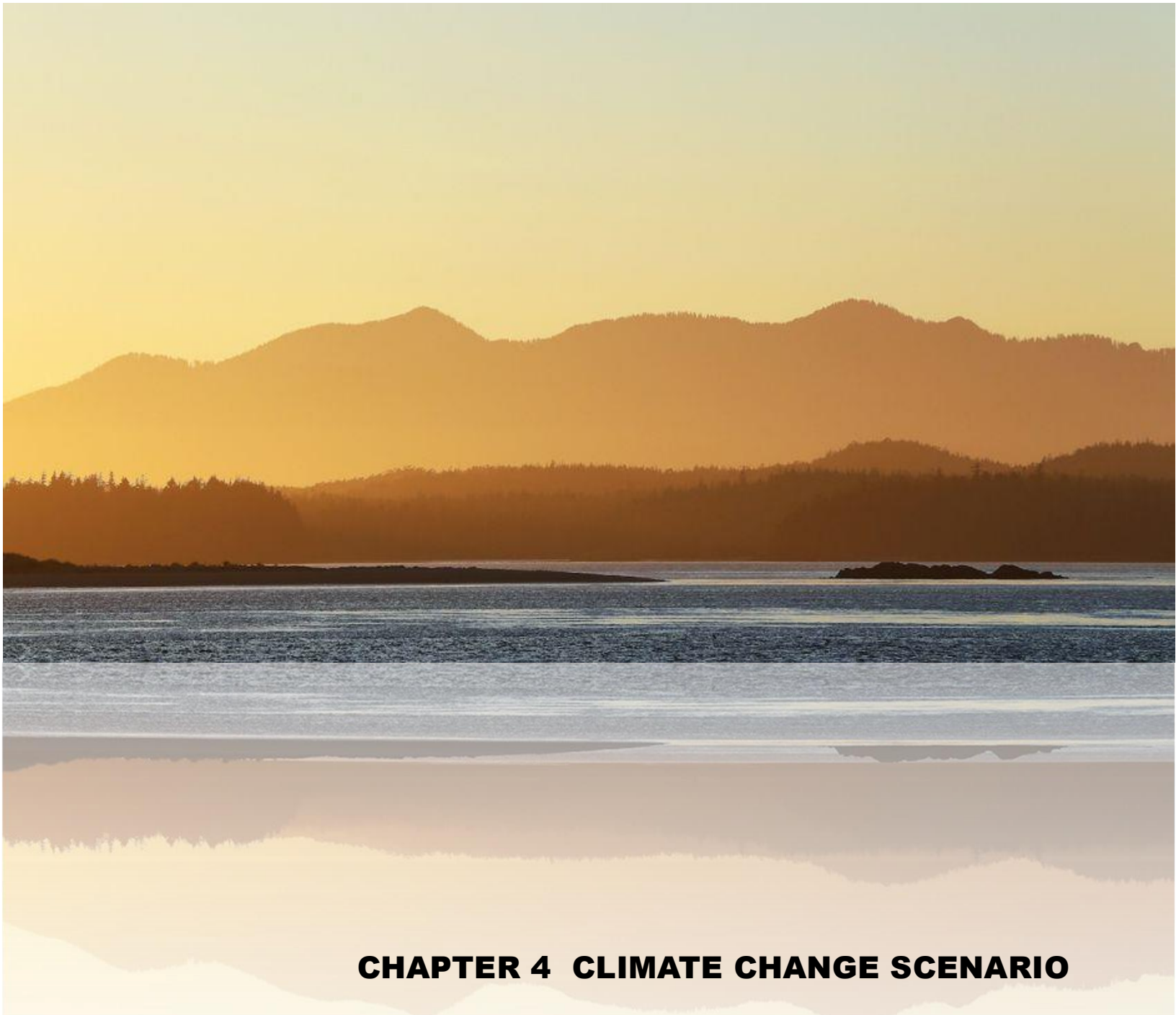
Figure 8: Literacy rate by county (LISGIS, 2017)



People who have lost their livelihoods may turn to the environment or small-scale extractive activities, such as illicit mining of minerals or sand, which puts pressure on the environment. Therefore, an increase in unemployment is associate with the degrading of the environment as an individual will use the environment for survival.

Table 2: Percent distribution of informal employment, vulnerable employment, and unemployment rates in Liberia (LISGIS, 2017)

Variable	Informal Employment rate	Vulnerable employment rate	Unemployment Rate
Liberia	79.9	79.5	3.9
Area of residence			
- Urban	72.5	69.1	6.5
- Rural	86.5	88.7	1.3
Gender			
- Male	69.0	67.9	4.5
- Female	90.9	91.1	3.2
Region			
- North Western	83.1	83.1	1.4
- North Central	88.6	91.5	1.1
- South Central	77.2	76.4	3.7
- South Eastern A	83.1	83.4	2.8
- South Eastern B	80.2	81.1	3.2
- Montserrado	69.0	64.1	8.0



CHAPTER 4 CLIMATE CHANGE SCENARIO

4.1. Introduction

This chapter provides a general overview of the climate of Liberia. It serves as the principal climate change **evidence base**[8] to support climate-informed decision-making processes. The chapter begins with general baseline characteristics of the country's climate, followed by a brief description of changes that have been observed in the recent past. The chapter then describes projections of potential future climate conditions. This information is used to analyze current and future vulnerabilities for the six priority sectors. It is expected that this chapter will be expanded and updated as Liberia's NAP process progresses, and as new data and information become available. So, this chapter should be viewed as a "living document."

4.2. Liberia's Baseline Climate

4.2.1 Precipitation

The climate of Liberia is predominantly equatorial with four distinct elevation zones: i) the coastal belt; ii) rolling hills; iii) plateaus, and iv) northern highlands. Except for the southernmost parts of the country, which receive rainfall year-round, most of Liberia experiences two seasons due to the movement of the inter-tropical convergence zone (ITCZ): a wet season usually falls between May and November and a dry season between December and April, when the dry and dusty harmattan winds blow off the Sahara Desert (USAID 2017). Also, in the southern zone, the rains have a relative break from the middle of July up till late August.

The average annual precipitation for Liberia is 2,500mm, but there are some regional variations. The average rainfall is highest in coastal areas where it exceeds 3,000mm annually and decreases towards the country's interior. For example, in Monrovia, the precipitation reaches 5,000mm per year, with a maximum in June and July, when nearly 1000 mm of rain per month falls, decreasing August (EPA, 2013).

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[8] *The **evidence base** refers generally to the scientific foundation upon which the NAP Process is built. This includes a synthesis of the best available data and information regarding climate change physical processes and hazards. The evidence base is a central part of the NAP process for at least two reasons. First, the evidence base should guide decision-making processes at all levels in Liberia, since it not only describes the types of changes that might be expected in the future, but also the potential magnitude of those changes, and the level of certainty about the likelihood of those changes that is supported by current science. Secondly, external financiers of climate change investments such as the Green Climate Fund and Adaptation Fund require that funding proposals have a robust evidence base tying the proposal to some aspect of climate change. Thus, this chapter can serve as an essential reference for planners and project developers.*

Liberia's mean annual precipitation has decreased since 1960; however, it remains unclear if this is a long-term trend or the variability in rainfall in the region. From 1901 – 2016, the country's mean annual precipitation monthly precipitation varies from 27 mm in January to 400 mm in September.

4.2.2. Temperature

The temperature in Liberia is strongly influenced by season. Temperatures during the rainy season are relatively low because of near-complete cloud cover, and slight diurnal[9] variation occurs**.** From 1970 to 1999, temperatures typically ranged from 24 to 25° C during the wet season and 24 to 27° C during the dry season. These temperature ranges are consistent with those reported by Coolidge (1930) of 24 to 26° C and 24 to 29° C during the wet and dry seasons, respectively. Temperature trends are similarly difficult to discern from the observational record. From 1960 to 2006, the mean annual temperature increased by 0.8° C(Stanturf, Stegall, Goodrick, & Williams, 2015). However, the temperature of Liberia generated from 2009 – 2012 collected from Robert International Airport weather station shows a variation in temperature from 23^{o}C to 33^{0}C annually.

4.3 Observed Changes

Climate change is already being experienced in Liberia. The sensitivity of Liberia's biophysical features to climate change and the level of vulnerability of each sector is being felt and observed (EPA, 2018). This section provides an overview of changes that have been observed starting in the second half of the 20th century.

4.3.1. Temperature

Overall, an observed increase in average annual temperatures of 0.8°C throughout the country, an average rate of .18˚C per decade. The total number of "hot nights"[10] increased by 57 between 1960 and 2003, while "cold nights" have decreased by an average of 17 per year.

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[9] *The diurnal cycle refers to the daily 24-hour cycle.*

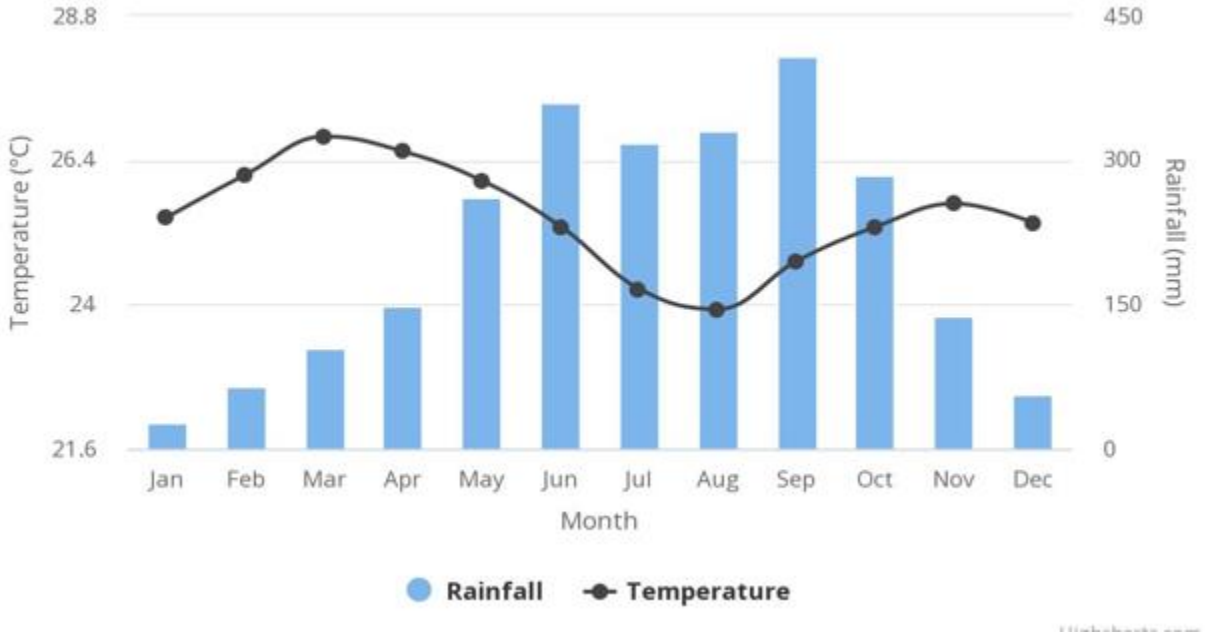
[10] *Hot nights" are those in which the temperature does not drop below 28˚C. This is an important indicator because hot nights have been shown to have significant health impacts, especially on the elderly, children, and pregnant and lactating women.*

4.3.2. Precipitation

Mean annual precipitation over Liberia has decreased since 1960. Still, it is unclear as to whether this represents a long-term decline attributable to anthropogenic climate change or if it is instead part of an existing pattern of interannual and interdecadal variability. A decrease in mean annual rainfall, increased frequency unpredictability of extreme rainfall events, and rising sea levels.

As temperatures rise and the air becomes warmer, more moisture evaporates from land and water into the atmosphere. More moisture in the air generally means an expected more rain and snow (called precipitation) and more heavy downpours.

Figure 9: Average Monthly temperature and rainfall in Liberia from 1901 – 2016 (climograph depicting baseline rainfall and temperature characteristics for Liberia).



4.4. Future Climate Trends

This section summarizes the most recent projections of the future climate for Liberia. It is essential to recognize that projections are not "predictions" for the future; instead, projections describe possible future conditions based on global climate modeling experiments. The information presented in this section is based on four different sets of models:

1. Ensemble projections for three representative areas of Monrovia, Nimba, and Sapo National Park;

2. Statistical downscaling[11] for the entire country;
3. Dynamical downscaling for the entire country; and
4. A constructed aridity index for examining the effects of climate change on social and natural systems.

4.4.1. Temperature

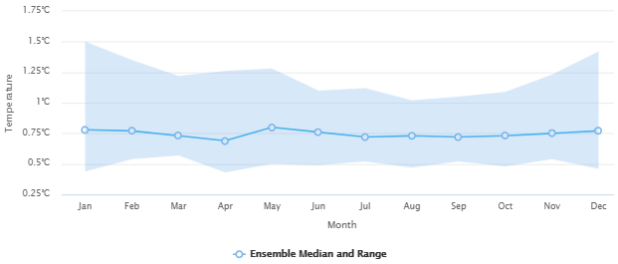
Projections of future trends for temperature and precipitation show that Liberia will continue to be affected by changing climatic conditions. Global Climate Modeling (GCM) data indicates that the mean annual temperature is projected to increase by 1.8^{o}C between 2040 – 2059. The RCP 8.5 projected 44 additional hot days with temperatures above 35^{o}C by mid-century, and the daily maximum temperatures are projected to increase by 1^{0}C to as such as 2^{0}C. The hot nights are also expected to increase by 37 – 89% and 49 – 95% of all nights for mid and end century, respectively.

According to Stanturf, et al. (2015), expected changes in temperature by 2050 and 2080 for Monrovia, Nimba, and Sapo National Park are expected. The general trends are for a warmer climate in most of the country. Estimates of temperature average will increase by 1.54℃ in 2050 and 1.90℃ in 2080, thus warming Monrovia during the dry season (1.30℃ by 2050 and 1.85℃ by 2080 for the wet season). Nimba is estimated to warm by an average temperature of 1.50℃ by 2050 and 2.13℃ by 2080 during the dry season. The southeastern region, especially the Sapo National Park projected to warm slightly with an estimated average of 1.44℃ by 2050 and 1.95℃ by 2080 during the dry season (1.29℃ by 2050 and 1.73℃ by 2080 for the wet season).

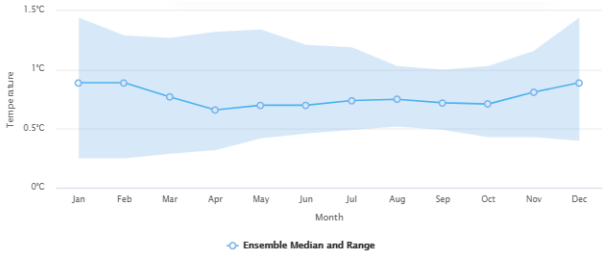
[11] ***Downscaling*** *refers to the process of increasing the spatial resolution of the global climate models (GCMs) that are used to develop projections of future climate conditions. Typically, these GCMs use grid cells of 150-200 square kilometers, and so their spatial resolution is quite course.* ***Statistical*** *and* ***dynamical downscaling*** *are two different approaches for inferring more localized detail from the outputs of the GCMs.*

Figure 10: Future change in monthly temperature for Liberia for 2020 - 2039

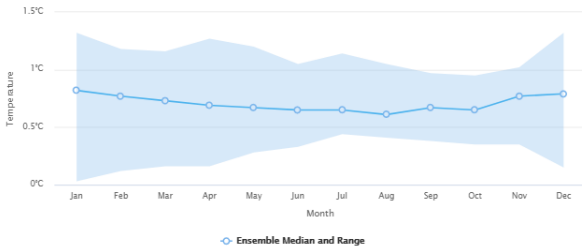
RCP 2.6 (Low Emission)



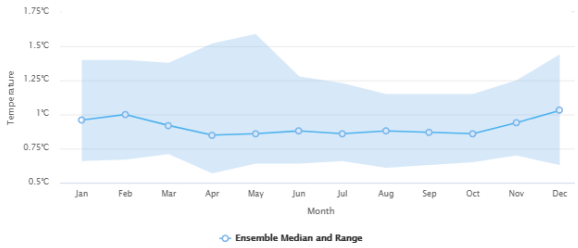
RCP 4.5 (Medium-Low)



RCP 6.0 (Medium-High



RCP 8.5 (High Emission)



The Regional Climate Models (RCMs) was used to project Liberia's climate from 2010 - 2050. Consequently, the mean air temperature increased by 0.4°C to 1.3°C (Table 7). The EPA (2013) projected that the average increase in the 2020s for temperature is estimated at 0.6°C. Therefore, it was estimated that the temperature would increase by a cumulative total of 1.3°C by the middle of the 21st century (NPRSCC, 2018).

4.4.2. Precipitation

Despite significant interannual variability, under RCP8.5, Liberia's monthly precipitation is projected to decrease by 1.3 mm per month in the 2040-2059 period. As a result, annual rainfall will decrease. In addition, despite the variability, there is an expected increase in extreme rainfall intensity and an anticipated reduction in dry-season rainfall in the southern regions by mid-century. In other words, while there is expected to be a decrease in total annual rainfall, the precipitation that does occur will be more likely to be concentrated in extreme events.

Liberia's climate was projected based on an ensemble of Regional Climate Models (RCMs), and the results indicated that the average increase in rainfall from 2010-2050 would be between 2.0% and 5.0%(Climatelinks, 2020) (Table 5). The current and the 2050 scenario regarding a spatial pattern of average annual precipitation, other projections have suggested that Liberia will experience a slight increase

in the total rainfall towards the interior of the country. In the future, the country demonstrates the highest average annual precipitation of 5,000 mm projected along the western coast in 2050. Further projections indicated that there would be an increase in rainfall along with the coastal areas during the rainy season, whereby the inland will experience a slightly reduced rainfall.

Figure 11: Surface Air Temperature increase 1960 - 2060

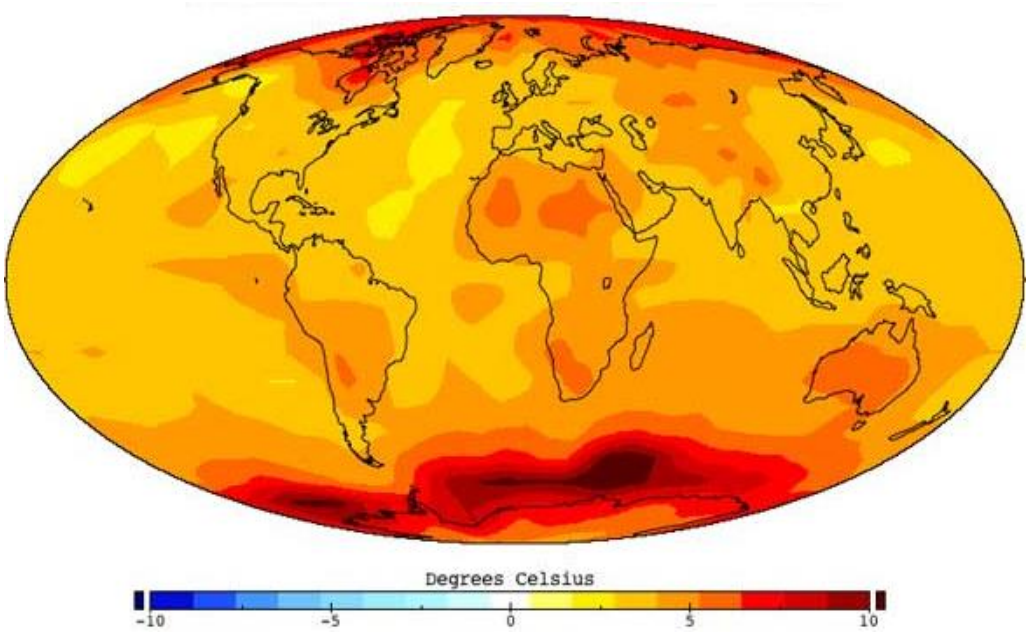


Table 3: Month-by-month description of changes by 2050

Month	Northern Region	Southern Region
May	Dryness due to increase temperature in the ocean	Increase in rainfall
June	Experience pockets of dry condition	Increase precipitation along the beach with more vigorous monsoon rain farther in the interior
July	Mid-dry season period. Increase areas of dryness will extend to the east	Rainfall along the coast will continue to increase
August	Dried condition increases	Change in rainfall pattern with less rainfall in the interior

The Liberia Climate Change Assessment report asserts that climate models' rainfall projections are mixed and uncertain due to the complexity of correctly reproducing several critical features of the atmospheric circulation patterns over West Africa (Stanturf et al., 2015).

The United States Department of Agriculture (USDA) ensemble modeling projections of rainfall among three representative meteorological stations also gave mixed and inconclusive results, lacking consistency and predicting decreases and rainfall increases across stations. However, with the warming projected, an increase in rainfall is the most likely outcome from a dynamic perspective. In general, abundant monsoonal rainfall is consistent with warmer tropical Atlantic sea surface temperatures as they enhance latent heat fluxes from the ocean to the atmosphere (USDA, 2013). Therefore, the change in climate in Liberia is associated with climate stressors depicted in Table 5.

Table 4: Mean Temperature and Precipitation Scenarios in the 2020s and 2050s for Liberia using RCM ensemble simulation to downscale ECHAM5 and HadCM3 A1b scenarios (EPA, Environmental Knowledge Management System 2013)

Horizon	Precipitation (%)	Mean Temperature (^{0}C)
2010-2019	+2.0	+0.4
2020-2029	+1.6	+0.5
2030-2039	+5.0	+0.8
2040-2049	+2.6	+1.3

Figure 12: Projected changes in Liberia's Annual

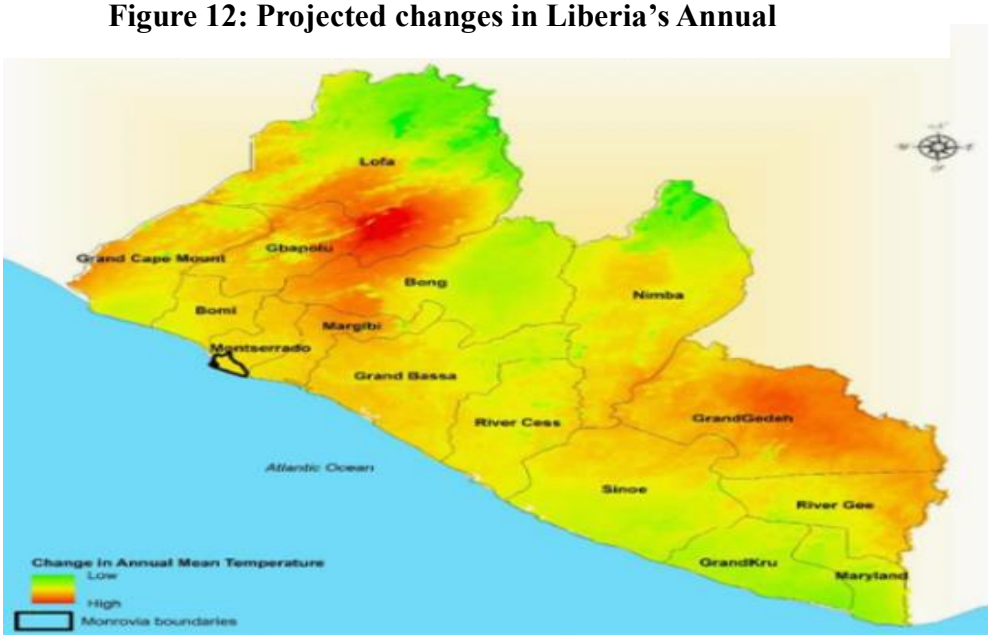


Table 5: Climate stressors and climate risks on major sectors in Liberia, including the energy and waste sectors (Foday, 2020)

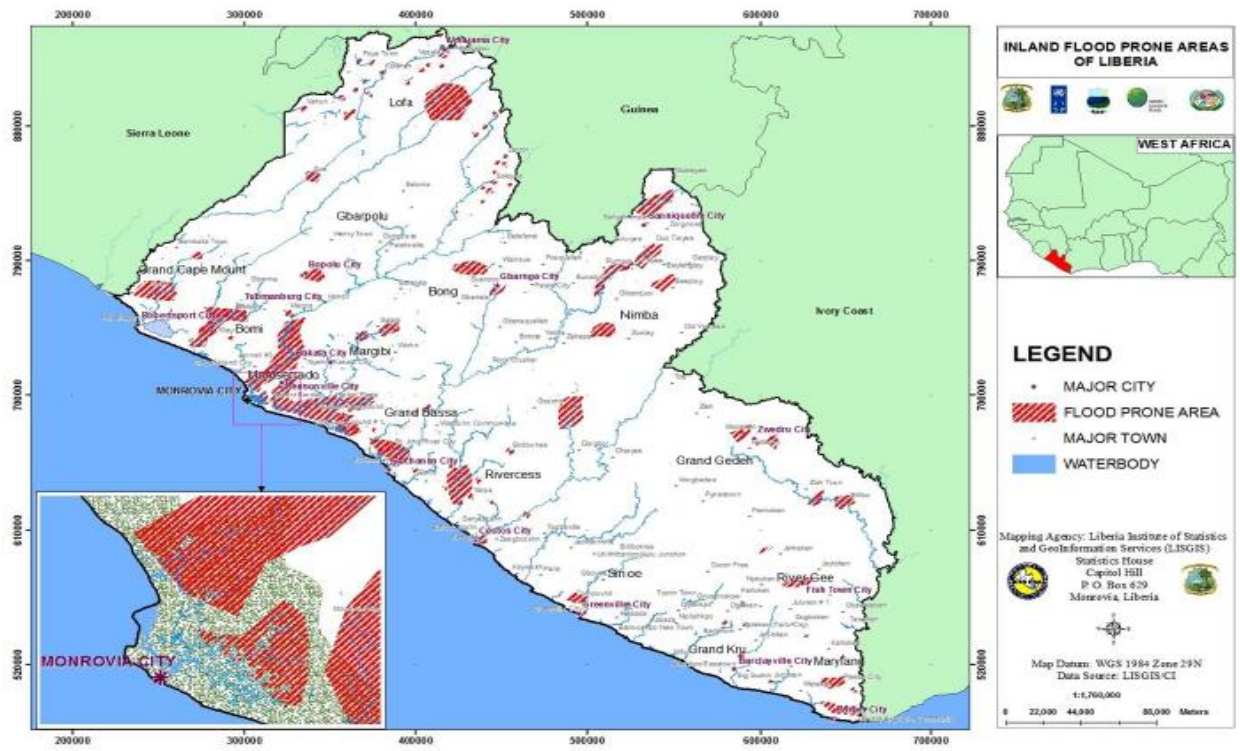
Sector	Climate stressors	Climate change risk
Coastal Zones	Sea level rise	Coastal flooding leading to displacement or migration of coastal populations; loss of life or crops or livestock Beach erosion leading to loss of settlement and damage to infrastructure as well as economic loss locally and nationally
	Increased temperature	Salinization of land, rivers, and aquifers
	Increased frequency of intense precipitation	Deterioration to the wetland and mangrove swamp
Water resources	Increased temperatures	Reduced water availability and the drying of shallow wells
	Increased frequency of intense precipitation	Deterioration of drinking water quality
		Insufficient water levels for the agriculture, fishing, and energy sectors
		Crops yield decreases
Agriculture	Increased temperatures	Increased incidence of pests (e.g., grasshoppers) and diseases (e.g., black pod and coffee rust)
		Increased heat stress on crops, particularly during the dry season
	Increased frequency of intense precipitation	Reduced growing season, maturation, and drying period for crops because of an overall increase in average annual rainfall
		Accelerated erosion of topsoil
		Waterlogging of rubber plantations
Fisheries	Increased temperature	Disruption to reproductive patterns and migratory routes
		Reduced aquatic biodiversity and productivity
	Increased frequency of intense precipitation	More frequent loss of fishing days due to bad weather
		Loss of income and livelihoods
		Reduced protein intake and nutrition deficits for the human population
Health	Increased temperatures	Increased incidence of vector-borne diseases (e.g., malaria, dengue fever, and yellow fever) due to the extended breeding range to higher elevations
	Increased frequency of intense precipitation	Emerging and re-emerging water and foodborne disease
		Exacerbation of respiratory diseases (e.g., asthma)
Forestry	Increased temperatures	Increase in the incidence of pests and diseases
	Increased frequency of intense precipitation	A decline in forest cover and health due to increased rainfall
		Increased erosion and runoff because of root loss
Energy	Sea level rise	Coastal flooding, leading to damage to energy supply facilities

Sector	Climate stressors	Climate change risk
	Intense temperatures	Beach erosion, leading to damage to energy supply facilities
	Increased frequency of intense precipitation	Insufficient water levels for energy generation. dryness of river basins, leading to an inadequate generation of hydropower
		Increased flooding, leading to damage to energy supply facilities
Waste management	Sea level rise	Coastal flooding, leading to damage to waste management facilities, landfills, etc.
	Increased temperatures	Insufficient water levels, leading to an inadequate water supply to manage the sewage systems
	Increased frequency of intense precipitation	Increased flooding, leading to damage to waste and sewage facilities, causing the widespread of waste-borne diseases in communities

4.5. Climate Hazards

Several climate-related hazards are affecting Liberia. When these interact with vulnerability-enhancing socio-economic factors (see Chapter 2) and the fragile social environment created by years of conflicts and poverty of the Liberian population, local or national disasters can quickly occur. The most common hazards experienced in Liberia are epidemics, floods, tropical storms, tidal abnormalities, coastal erosion, and droughts. In addition, human-induced disasters result from war, refugees, internally displaced people (IDP), and chemical and harmful elements. In the future, meteorological hazards such as floods and droughts are likely to increase due to global warming. In addition, industrial development might further lead to oil spills and other toxic waste disasters (NDMA, 2020). Therefore, the Climate hazard focuses on two categories: existing climate hazard and emerging climate hazard.

Figure 13: Major hazard-prone areas in Liberia as of 2019(NDMA, 2020)



4.5.1. Flooding

Floods induce disasters when human settlements have an overflow of water beyond the usual confines. A report from the National Disaster Management Agency (NDMA) indicated that in 2017, more than 100,000 people were affected by floods in the country.

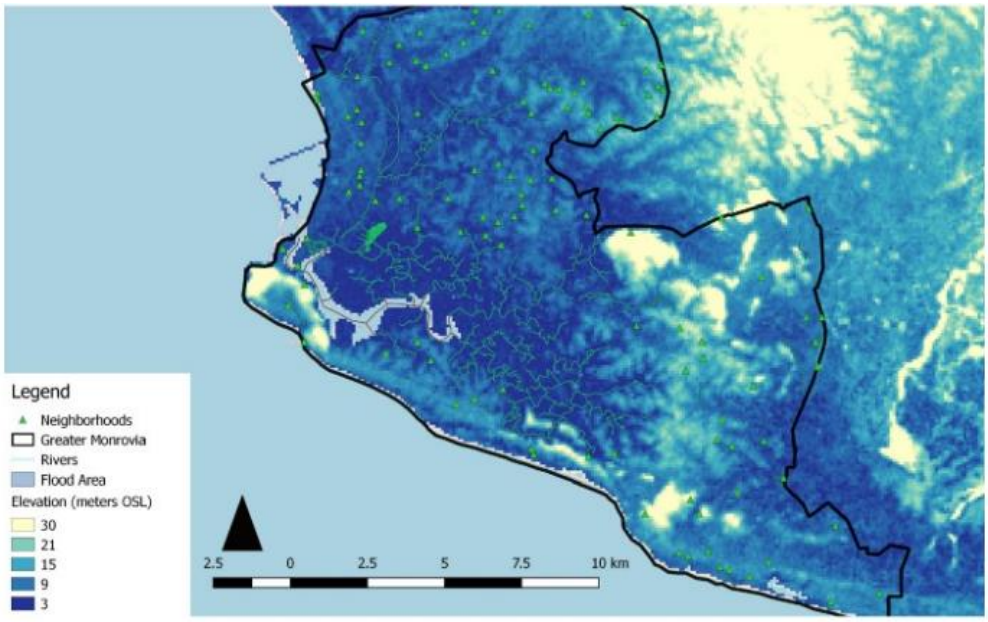
In Liberia, floods are one of the most frequent hazards, which occur during rainy seasons. Floods are costly in terms of human and economic loss. Direct impacts of floods are drowning, still water, an outbreak of diseases, damage to infrastructure, and loss of farmlands.

Table 6: Liberia flood reports, NDMA, 2018 (all affected communities are in Montserrado County)

Affected Community	# of person	Total male	Total female	Total children	Property damaged
West Point Kru Beach	280	126	70	98	10
New Kru Town	5000	1750	1250	2000	7
New Kru Town Point 4	350	105	70	175	10
New Kru town Popo Beach	187	59	45	83	6
New Kru Town Colonel West	560	196	112	252	40
New Kru Town Fundye	71	28	30	13	16
New Kru Town Bonis Bridge	3500	1400	875	1225	15

Affected Community	# of person	Total male	Total female	Total children	Property damaged
Caldwell Cheachepo Road, Geneve Community	2500	880	480	836	3
Caldwell Road Crab Hole Community	300	135	60	105	5
Caldwell Road Beyond Monoprix Supermarket	6000	2000	1250	1750	10
St. Paul Bridge Crab Hole	3000	1200	750	1050	N/A
St. Paul Bridge Whea Town	2500	875	500	1125	N/A
Total	27,948	8,754	5,492	8,712	122

Figure 14: Elevation model to identify areas of a high risk of floods in Monrovia(Gonz, 2019)



In Margibi County, flooding has affected 2,556 people, with Joe Blow Town the worst hit, with 1,596 people affected. Elsewhere in Margibi County, Unification Town, Duwo Town, and Duazon were also affected.

4.5.2. Coastal Erosion

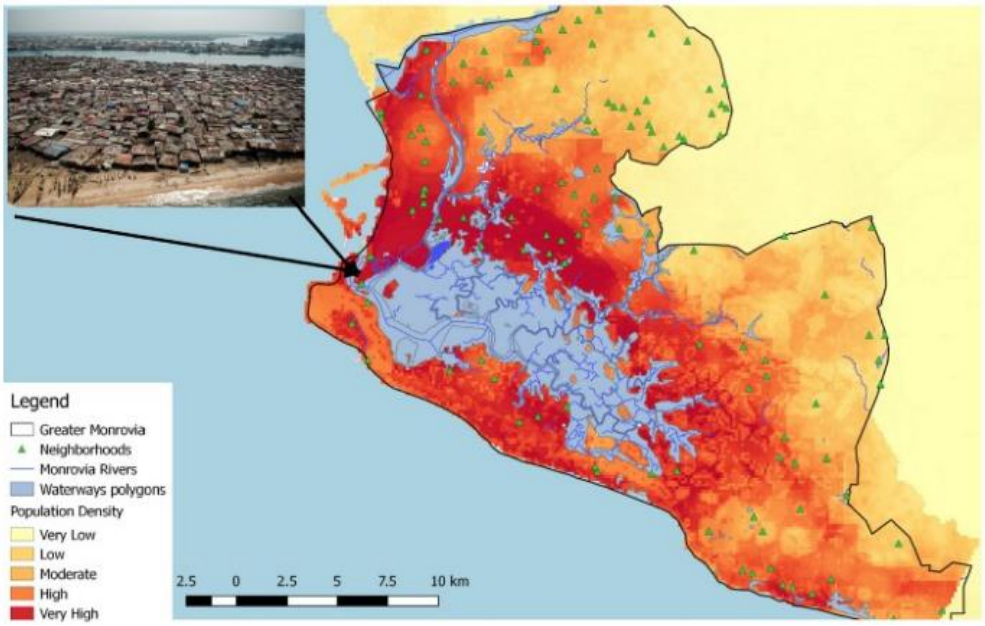
Coastal erosion has become a significant problem in Liberia's coastal areas, mainly exacerbated by changing weather conditions, sea-level rise, and other human activities. The result being that populations are being displaced, and infrastructure is lost due to high rates of coastal erosion.

Figure 14 a: Elevation model to identify areas of a high risk of floods. A = Monrovia; B = Montserrado County; C = Margibi County

Liberia's coastal cities are experiencing increased sea flooding, accelerated coastal erosion, and seawater intrusion into freshwater sources; these processes will be exacerbated by climate change and sea-level rise. These processes have contributed to a deterioration of sandy and gravel beaches and barriers, loss of coastal dunes and wetlands, and drainage problems in Monrovia. In the future, coastal settlements will continue to be exposed to pressures whose impacts are expected to be largely negative and potentially disastrous in some instances.

Most coastlines are susceptible to erosion that will be intensified with increasing sea level rise. With a one-meter sea-level rise, parts of Monrovia's capital city and its environs, West Point New Kru Town, River Cess, Buchanan, and Robertsport, will be lost, as the more significant parts of these areas are below one meter. In addition, the mangrove systems along the coast will be lost. About USD250 million worth of land and infrastructures such as Hotel Africa will also be lost.

Figure 15: Population density at risk of flooding (Gonz, 2019)



4.5.3. Windstorm-prone Areas

Although the geographical coverage and duration of storms are sometimes small and short, the damage and losses caused by windstorms are enormous. According to the National Disaster Management Agency, approximately 150,000 persons have suffered from the impact of intense storms over the recent three years in Liberia. Damage, including falling of trees on vehicles and homes, dropping of power lines and poles, De-roofing of buildings, flying of zinc and other dangerous objects, eye injuries caused by flying dust or debris, is primarily attributed to exposure and low capacity for storm-resistant construction practices and inputs.

4.5.4. Emerging Climate Hazards

Drought. The severity of the drought depends upon the degree of moisture deficiency, the duration, period of occurrence, and the affected area's size. Although this is not a problem now in Liberia, global warming (hence climate change) directs us to ensure preparedness in this area. Therefore, establishing a commission to prepare Liberia in drought is critical to the NAP process.

4.6. Climate Change Vulnerability and Impact

The baseline and projected climate change in Liberia indicate that country has experienced some physical processes relating to changes in climate. Some physical processes include variations in rainfall

patterns and weather conditions, rising sea levels, increased frequency of extreme weather events, and variation in the country's temperature.

These physical processes can either have a direct or indirect impact. For example, in Liberia, the impact of climate change includes deforestation, energy, an increase in agricultural pests, quality of water resources and quality in some regions, displacement, and migration of populations.

The impact of climate change can induce drought-associated effects on forest ecosystems, thereby decreasing the sector's economic and social benefits. This could exacerbate the incidence of poverty. Forecasts from climate models suggest an increased risk of droughts in tropical forests, including Liberia's forest, over the next few decades, potentially threatening the large existing carbon due to the impact of climate change it creates adverse effects that are and susceptible and unable to cope, thereby creating vulnerability and risk for communities. Vulnerability and adaptation assessments have revealed that Liberia is faced with climate change and variability, leading to extreme events, which negatively impact agriculture, forestry, health, energy, and other sectors. Climate change in Liberia's impacts is marked by irregular rainfall patterns, flooding, high temperature, and coastal erosion. These factors result in crop and livestock losses that intensify food insecurity and loss of income. For the most part, women and children are particularly vulnerable to the impacts of climate change. However, their unique knowledge and perspectives also provide opportunities for inclusive, equitable, and efficient adaptation responses and coping strategies. The limited supporting infrastructures increase the vulnerability of the population. Coastal areas in Liberia are the most populated and economically vibrant areas. Sea erosion continues to pose increasing threats to coastal cities' shorelines, including major infrastructures and investments. It can also lead to displacement, loss of lives and properties and can severely undermine national security. The climate vulnerability and variability assessment followed the International Panel on Climate Change (IPCC) climate change vulnerability and risked conceptual framework as defined in its fifth assessment report (IPCC, 2013).

The National Adaptation Plan, as part of its mandate, conducted a climate change vulnerability and risk assessment in six key sectors of the country, which include (Table 9):

1) Agriculture Sector
2) Energy Sector
3) Fisheries Sector
4) Coastal Zone
5) The forestry sector, and
6) Waste management sector

4.6.1. Agriculture Sector

Agriculture has been an essential source of economic growth since the collapse of the formal economy during the civil war. The sector contributes 35.2 percent of GDP and provides livelihoods to 67 percent of the population. Rice is the country's primary staple crop, cultivated by 74 percent of farmers. Rice is highly sensitive to increased humidity, temperatures, and intense rainfall. To the pests that thrive in these conditions, a However, rising temperatures may render areas in the north suitable for rice production where it previously was not. At the same time, intense rainfall and associated flooding and erosion of sowed fields may counteract these gains, depleting nutrient-rich topsoil and reducing the total arable land area. Cassava, Liberia's second most important staple crop, is far more resilient to climate changes (notably higher temperatures) and may provide an alternative food source in an increasingly erratic climate. Liberia's major agricultural exports (rubber, cacao, and coffee) are also sensitive to changing weather conditions.

Rubber production when done responsibly increases biodiversity and carbon sequestration and reduces carbon dioxide emissions from deforestation. Five main climate factors affecting rubber planting were the mean temperature of the coldest month, mean extremely minimum temperature, monthly mean temperature ⩾18 ℃, annual mean temperature, and annual mean precipitation (Liu, Zhou, Fang, & Zhang, 2015). It requires high temperature throughout the year – ranging between 20°-35℃ or an average monthly mean of 27°C. Less than 20℃ temperature is detrimental. Rising temperatures, drought, and heavy rain will affect rubber yields and disease outbreaks. Rubber growers can boost resilience by adopting better cultivation methods but will need more support (Chin, 2020).

According to a report from garden guides on Purdue University cacao tree research, cacao trees can tolerate temperatures as high as around 35˚C and as low as 13 ˚C. Minimum temperatures above 18˚C and an average temperature of around 26.5˚C degrees are recommended for optimal growth. Cacao trees do not tolerate drought well and require climates with high precipitation and humidity to thrive. The plant can tolerate rainfall from around 500mm to over 3800mm per year. The soil, however, must drain well (Whittemore, 2017). Unlike many other crops and resources, coffee production has decreased due to changes in temperature, longer droughts, and increased invasion of pests. The study showed that cocoa farmers are vulnerable to hunger and poverty due to excessive climate change that might come in form of floods, high temperatures, and heat, which often affect the performance of cocoa plantations (Oyedokun & Oyelana, 2017).

Rising temperatures will bring drought, increase the range of diseases, and kill extensive swamps of the insects that pollinate coffee plants. According to a recent study in the Journal of Climatic Change published in the Inter-American Development Bank, about half of the land currently used to produce high-

quality coffee could be unproductive by 2050[12,13]. With Liberia extreme temperature, the Agriculture Ministry and the Forestry Development Authority need to work with cacao farmers to improve their finance.

Increasing intensity of rainfall events could damage rubber production and increase costs to maintain proper drainage on plantations. Cacao and coffee (both Arabica and Robusta) have specific climatic requirements for optimal productivity levels that may come under pressure as rising temperatures reduce moisture levels and exacerbate pests and diseases that thrive in hot conditions.

In Liberia, as much as 70% of the population depends on agriculture for their livelihoods. Rural areas are as much as 80% vulnerable to food insecurity (EPA, 2013). Climate projections suggest that rice will be negatively impacted by higher temperatures, even with adequate precipitation. Upland rice, the predominant cropping system, will be affected by changes in the seasonality of rainfall. **Cassava is a more resilient crop** adapted to high temperatures, drought, and erratic rainfall. Geographically, agricultural production in Bong, Lofa, and Nimba will most likely be affected due to climate change (GCF, 2016).

The Liberia Climate Change assessment report of 2013 published by USAID found that most rural households are food insecure; that is, 80% of the rural population are moderately vulnerable (41%) or highly vulnerable (40%) to food insecurity (USAID, 2013-2019). Another impact of climate change in the agricultural sector is the reduction of livestock population by 10%. In Liberia, the livestock sector contributes 14% of food (*MoA, 2006*). The difficulty facing livestock is weather extremes, e.g., Climate intense heat waves, floods, and droughts.

The fluctuation of rain has impacted the agricultural sector. It was obtained from local stakeholders impacted negatively impacting farming season; results obtained from a GCF-funded project on agriculture vulnerability(Fobissie et al., 2019). An observatory within the Paynesville belt shows that the garden season, which usually begins in October, has been disrupted due to variations in seasonal rainfall. Farmers are vulnerable to shifts in climate variables when considering that most households live below the poverty line. Similarly, the fact that temperature shifts are particularly intense in the mid-dry season carries implications for farming during the dry season. Furthermore, the rain is heavy during the early stage of the rainy season affects farmers' decisions to plant, which severely impacts their survival.

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[12] *Inter-American Development Bank*
[13] *Financial Time*

Figure 16: Map showing the vulnerability of the agricultural sector to climate change(Fobissie et al., 2019)

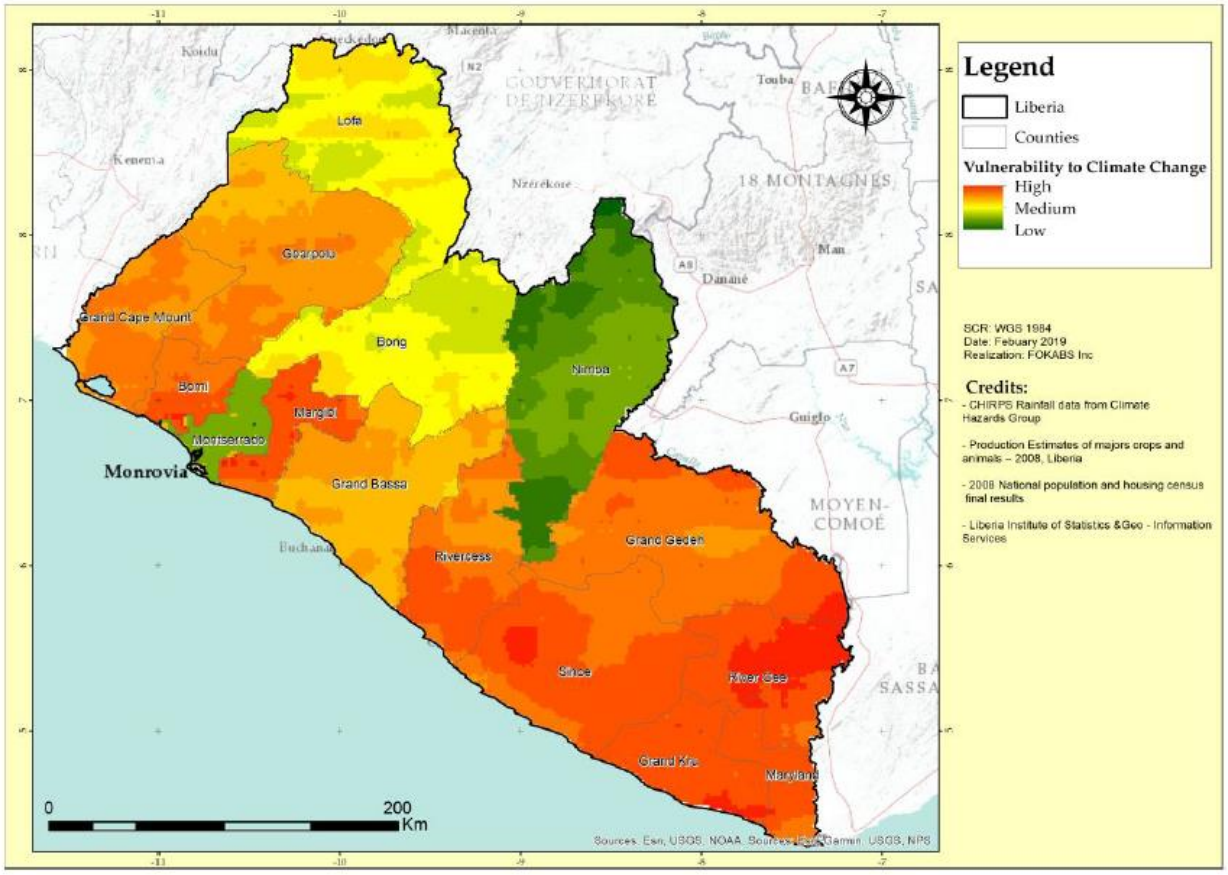
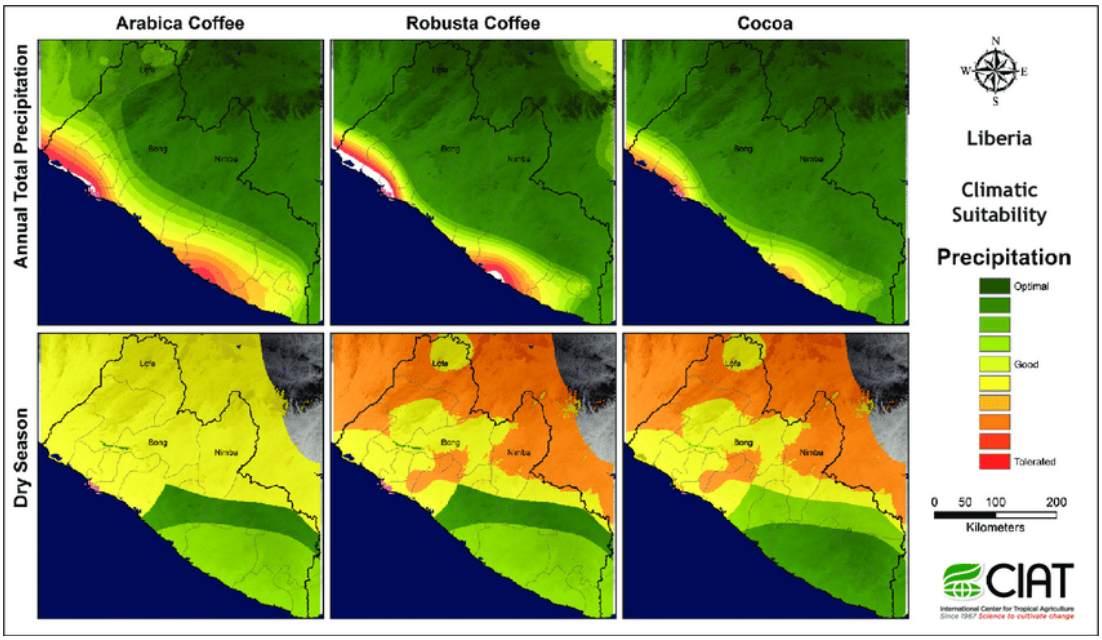


Figure 17: Precipitation distribution in the Agriculture Sector



4.6.2. Coastal Zones

Liberia's densely settled coastal zone is vulnerable to risks resulting from climate change(Balk et al., 2009). Sea level rise and associated coastal flooding and erosion are increasing stress on Liberia's extensive and productive coastal zone. In addition to supporting essential agriculture and fishing activities, the coast is home to almost 60 percent of the population, much of which resides in areas already at risk from inundation. Liberia's Environmental Protection Agency is concerned that the rise in sea level will increase migration to higher lands and/or result in shock waves of migration to the interior when coastal inhabitants seek refuge from flooding. Monrovia, such as the West Point Slums, has had to be evacuated because of storm surges. If sea levels rise one meter, areas of major cities such as Monrovia, New Kru Town, River Cess, Buchanan, and Robertsport will be submerged, incurring losses of land and infrastructure worth $250 million(NPRSCC, 2018). In addition, rapid coastal erosion (both from sea level rise and sand mining) already puts settlements and infrastructure at risk in areas like Buchanan, Greenville, Harper, and Robertsport. Rising sea temperatures and intense rainfall levels will impact unique mangrove ecosystems through erosion, leaving the coast even more exposed to storms and wave damage. These factors will also negatively impact fish and other marine species that rely on mangroves as a habitat and food source.

A rise in sea level along the coast in Liberia could cause saltwater intrusion into freshwater areas. Coastal flooding is an obvious and immediate threat to economic growth, energy supply, roads and transport,

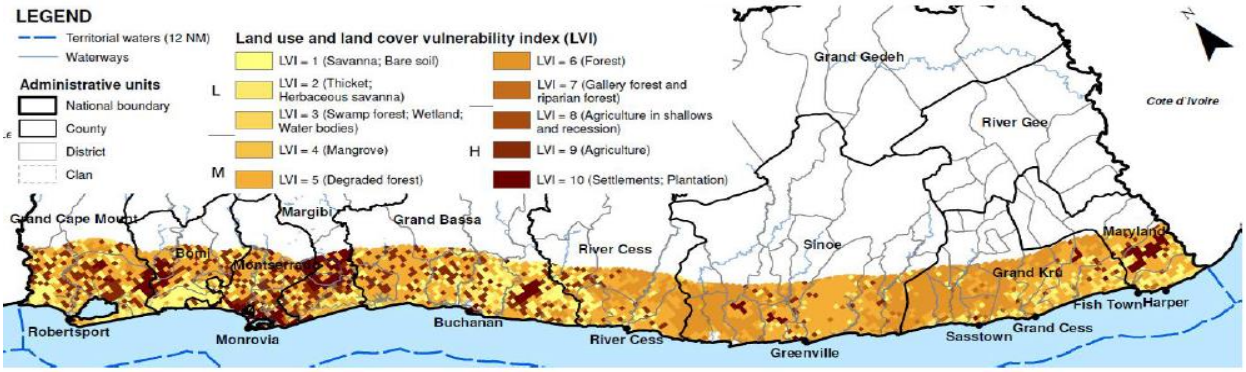
food and agriculture, education, health, water and sanitation, and social protection. The potential rise in sea levels could add to existing coastal erosion trends in Buchanan and Monrovia, with a loss in infrastructure and land of around $250 million apart from the population's social and psychological stress. The more than 550km of coastal areas in Liberia is highly populated and can easily be affected by climate change. The combined effects of ongoing coastal erosion, climate change-induced sea-level rise, evolution in storms frequency and intensity, increases in precipitation, and warmer ocean temperatures will combine to create significant risks in coastal areas.

The study on the climate vulnerability and risk assessment of the coastal sector mapped the vulnerability of the coastal zone into four categories. The categories are as follows:

1. Land use and Land cover vulnerability

About 17% of the coastal area is a built-up area, under plantation or some sort of agriculture - all three categories specifically having extremely low resilience to climate change. In addition, many houses have low strength due to the structural instability and construction of construction (dwellings that can be considered shanty structures, sometimes houses made of low resilient materials, i.e., tin). Built-up areas and areas under plantations or some sort of agriculture - due to livelihood importance, low resilience of structures, the dependence of the population on agricultural products or possible economic losses in the developed areas (ports, industrial and merchant areas), concerning Land Use are all considered as highly vulnerable. Similarly, a high proportion, about 62%, of the coastal area is under some form of economically and biodiversity valuable forests and mangroves (with highly valuable ecosystem services) and thus raising the overall vulnerability of the coastal region to a medium range.

Figure 18: Land use and land cover vulnerability of coastal Liberia is characterized by a high proportion of vulnerable areas under settlements, agriculture, plantations, and precious forests and mangroves(Kalinski, 2019).



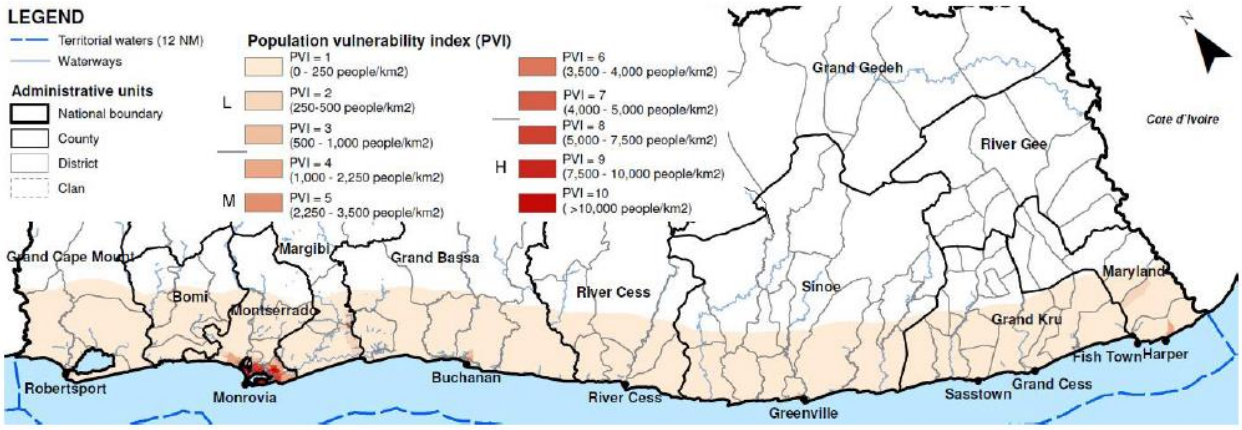
As losses in agriculture, forests, and ecosystem services can be directly linked with property and livelihood loss, such areas are critical. Therefore, those relations need to be taken care of while evaluated according to the degree of hazard in the respective area.

2. Population vulnerability

The average population density of Liberia is low according to the 2008 census (Government of Liberia, 2009). Unfortunately, this is not the case, and therefore, the verification process was essential. The verification process revealed that although Liberia's total population is relatively low and with a low average density, that is not true for the areas where the population is placed. Most of the coastal population is concentrated around coastal settlements, especially in Monrovia Metropolitan Areas (MMA), where population density is in some city areas such as the West Point, New Kru Town areas.

The population vulnerability map shows that the Monrovia Metropolitan Area (MMA) is the most vulnerable considering population density. This is hardly a surprise knowing that MMA accounts for one-quarter of the Liberian population. Other weak areas include the rest of the more significant coastal settlements: Buchanan in Grand Bassa County, Greenville in Sinoe County, and Harper in Maryland. Socioeconomic variables primarily shape climate change vulnerability. It concludes that all bigger coastal towns in the entire project area are vulnerable (with medium or high degree) due to their higher population density relative to rural areas.

Figure 19: Population vulnerability assessment of the project area leads to the conclusion that the most vulnerable areas are coastal towns' areas (medium or high degree) due to higher population density relative to rural areas (Kalinski, 2019)



4.6.3. Fisheries Sector

There is no doubt that the fishery sector has enormous potential for lifting the poor out of poverty and, over the years, has provided employment and livelihoods for more than 11,250 people (FAO, 2006). Species of fish are an essential component of the Liberian diet and the primary source of protein in coastal areas. Liberia's fisheries include coastal marine fisheries involving industrial and artisanal activities; inland river and lake fisheries, which are underdeveloped and artisanal; and aquaculture, which consists of small, freshwater ponds producing tilapia in rural areas non-coastal communities. The fisheries sector suffered during the civil war and now faces risks from climate change and climate variability. However, climate change is a major driving force to the decline in fish species in Liberia's fishery sector (EPA, 2018). Indeed, climate change has impacted the fishery sector by shifting the distribution of species, biodiversity loss, and loss of livelihoods (USAID, 2017a). The USAID (2017) report indicates that an increase in temperature is causing disruption to production patterns and migration of fish species and has reduced aquatic biodiversity and the overall productive capacity. While on the other hand, the increased frequency of intense precipitation has led to more frequent loss of fishing days caused by bad weather, loss of income and livelihoods, and reduced protein intake.

Rising sea surface temperatures reduce biodiversity and overall stocks because of death, diminished reproductive cycles, and migration to cooler waters. Changing rainfall patterns, particularly during the dry season when the inland river and pond levels are low, are causing significant numbers of fish to die. Those that survive are often exposed to waters contaminated from pesticide runoff and other pollutants.

In general, the fisheries sector has been affected by climate change through increased sea surface temperature. Specific impacts depend on the ecosystem and fishery, as nearshore and marine fisheries experience different impacts that freshwater fisheries. For example, changes in precipitation and evapotranspiration are more likely to affect freshwater fisheries through increased sedimentation from extreme events, lower water levels from drought, and other biophysical processes including eutrophication. Climate-induced differences in Liberia's biophysical characteristics, along with extreme events, have had significant effects on the ecosystems that support fish (mostly inland). With respect to marine fisheries, climate change risk assessment indicated that fish species might experience low productivity or may migrate away from Liberian waters. Decreasing fisheries productivity will impact communities in several ways, including reduced earnings from fish exports and increased food insecurity (Fobissie et al., 2019).

Inland fisheries, particularly crucial for small-scale artisanal fishers in Liberia and an integral part of Liberian rural livelihood and food security systems, could be severely impacted by climate change (USAID, 2017). Nearly the entire inland fishery lies in the Southern Upper Guinea Aquatic Eco-region. About 20% of the 151 fishes from the eco-region are endemic. Nevertheless, so little is known about the

inland fishery regarding rates of exploitation, diversity, and status of fishes exploited, several fishers, and state of the aquatic ecosystem that projections of climate change impacts on this critical national resource are virtually impossible beyond broad generalizations. Precipitation and evapotranspiration changes, including an increase in extreme events (e.g., exacerbated floods, severe drought), affect inland waters causing changes in magnitude and timing of high and low river flows (USAID, 2017). This hydrological variability could adversely affect fish habitats, reproduction, growth, recruitment, and mortality (USAID, 2017). Therefore, the impactful climate change planning for these resources would require better information about current formal and informal management regimes and levels of exploitation. Agriculture Through the EPA and the Ministry of established NAFAA, a commission to work with small-scale fisher to improve their fishing activities.

During the fisheries sector assessment, 116 fishermen respondents associate the fishery sector's climate vulnerabilities to sea-level rises, flooding, and coastal erosion. Due to temperature increases, brown tides[14] have also destroyed fishing nets so badly that debris was seen on the beaches in Robertsport. Besides, most respondents from our interviews revealed that sea storms resulting from increased precipitation have reduced fish catch, which has impacted the activities of the women involved in drying fish. Finally, the fishery sector's vulnerability to climate change in Liberia is presented(Fobissie et al., 2019).

Climate change is expected to have severe impacts on the marine environment. An increase in water temperatures will contribute to a restructuring of marine ecosystems with implications for ocean circulation, biogeochemical cycling, and marine biodiversity. For example, ocean acidification will affect some calcium carbonate-secreting species (as mollusks, planktons, and corals) to produce their shells or skeletons. Warmer and more acidic seawater will, therefore, negatively affect fishery and aquaculture. Moreover, extreme events' intensification is expected to affect human maritime activities other than fisheries, maritime transport, port activities, and offshore energy production.

4.6.4. Forestry Sector

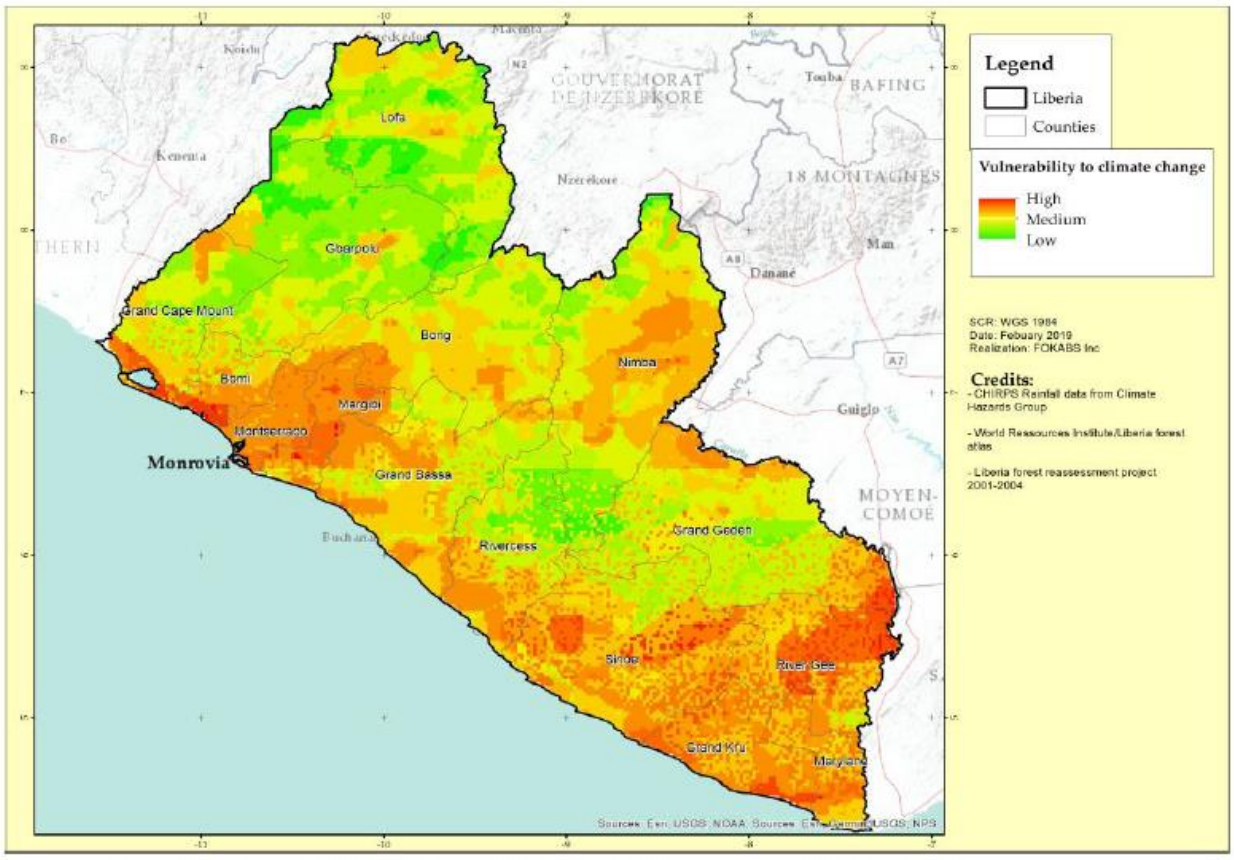
Liberia is home to forty percent of West Africa's forest cover used for food (non-timber forest products and wildlife), fuelwood, medicinal products, and energy for nearby communities. The forests also

[14] *Brown (and red) tides can occur when certain algae species reach high concentrations, or "blooms," that discolor water. Some of these algae species can harm some marine life under certain conditions. Brown tides can reduce water transparency to less than a foot in some cases, affecting seagrass by limiting light penetration in the water column.*

serve as a source of revenue for the government. The impacts of climate change on forests will vary widely based on the species involved and other factors. With increasing carbon dioxide (CO_2), forest productivity will likely increase until other impacts of climate change, such as increased risks of drought, forest fire, pests, and invasive species, present additional stressors to forests. As temperatures rise, the distribution and composition of tree species will continue to shift northward.

Rainfall projections are too inconclusive to predict with certainty if climate change will significantly impact tropical forests. However, substantial evidence shows that increased duration and intensity of rainfall leads to slower tree growth and, in more severe cases, rotting because of waterlogged tree roots. Increased runoff due to heavy rain, combined with root loss, may cause greater siltation of surrounding reservoirs and rivers. Some forest areas may become more susceptible to pests, such as the pine caterpillar *(Dendrolmus punctatu),* due to changing climatic conditions, including increased temperatures (USAID 2017). Villagers have reported changes in forest ecosystems, including increased mortality of important tree species, phenological shifts, reduced yields of NTFPs such as kola nuts, and altered behaviors of some invertebrate species (e.g., snails).

Figure 20: Map showing the vulnerability of Liberia's forest areas (Fobissie et al., 2019)



4.6.5. Waste Management

The vulnerability and risk assessment project for two sectors, waste management, and energy, were funded by the GCF and executed by UNDP under the NAP project. For the waste management vulnerability and risk assessment, the impacts of climate change on the sector are not well understood owing to limited data. The waste management sector of Liberia is challenged with inadequate waste management systems, poor engineering facilities, inadequate regulation, and insufficient logistical and human resource capacity to handle the enormous waste generated in densely populated communities. These baseline challenges make the sector more vulnerable to the potential impacts of climate change. Furthermore, with such a breakdown in the country's sanitation system, populated communities (incredibly informal settlements) are prone to water-borne diseases due to poor waste management. In addition to being vulnerable to climate change impacts, the waste sector could also be a significant contributor to global warming due to poor management, as solid waste is a substantial source of greenhouse gases such as methane. The IPCC Fifth Assessment Report (AR5) (IPCC, 2014) states that continued emission of greenhouse gases (GHG) from places like landfills/dumpsites could cause further warming and long-lasting changes in the climate system, increasing the likelihood of severe, pervasive, and irreversible impacts on people and the environment. These changes could have significant implications on social, economic, and environmental processes affected by extreme weather, thus threatening current ecosystems' stability (IPCC, 2013). Therefore, it is essential to quantify the GHG in Liberia and integrate waste into the national fight against climate change(Foday, 2020). At the same time, investments in improving the climate resilience of the waste management sector are likely to have mitigation co-benefits.

4.6.6. Energy Sector

In 2004 it was estimated that 95% of the Liberian population depended on biomass, particularly on firewood and charcoal, for cooking and heating (MME, 2009a). However, only 2% of the rural and 10% of the urban population have access to electricity through diesel generation (GoL, 2012). Furthermore, assessments have shown that despite the widespread use of biomass and fossil fuel for energy generation, Liberia is yet to optimize energy generation using these resources. For instance, petroleum products (gasoline, diesel) are used primarily to power private generators and automobiles.

Despite these options for diversification, the energy sector of Liberia is highly vulnerable to the impacts of climate change. These effects are or will be manifested in many facets of the energy industry, especially the hydrology and forest resources that have great potential for energy supply.

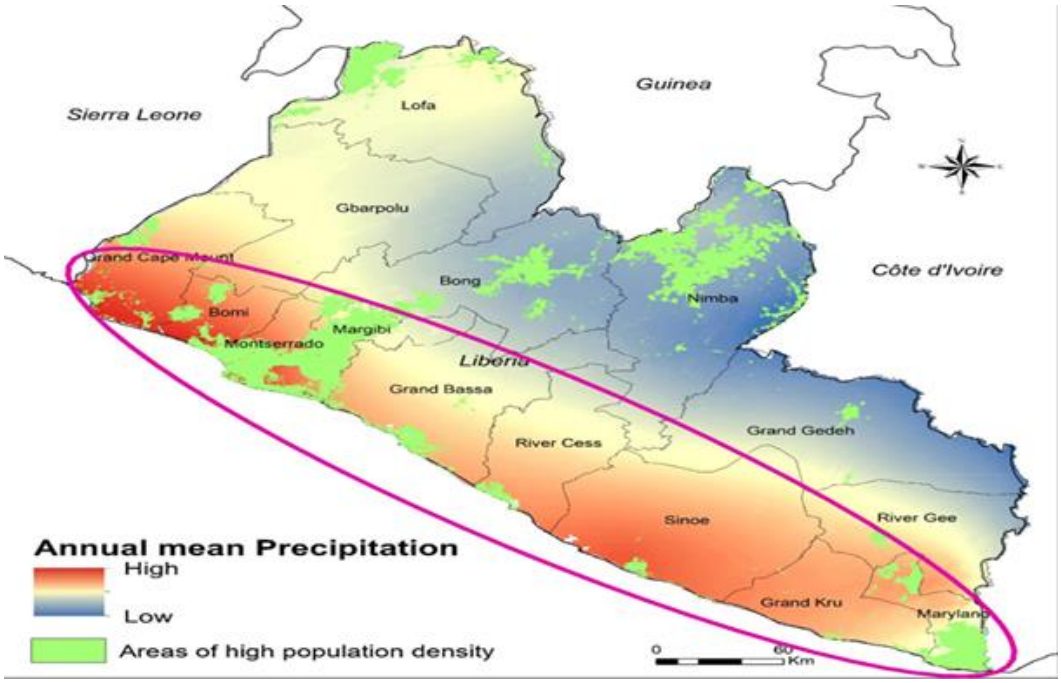
Seasonal and daily temperatures and precipitation changes would affect the timing of peak electricity demands and these peaks' sizes. For instance, very "hot" days and nights are already being

observed in some parts of the country (e.g., Monrovia), already increasing demands for electricity to cool temperatures.

Hydropower is a significant energy source for the country; extended periods of drought could reduce water availability for hydropower generation, particularly in parts of the country projected to be heavily hit by increased temperatures, which are also origins of significant rivers. For example, a good stretch of St. Paul's river, the source of the bulk of the country's current hydroelectric power, falls within the country's climate hot zone, affecting the overall productivity of the river. Thus, during the dry season (hot season) in the country where temperatures increase, the production of the hydroelectric current drops significantly because of the decrease in the St. Paul discharge.

Similarly, changes in temperature and precipitation could affect water availability for cooling power generators. However, the country's overall good news is that future discharge is expected to increase for rivers in Liberia by 5 to 10%, the same for runoff. This could contribute to an increase in hydroelectric potential. However, extreme rainfall is associated with sedimentation, which could affect the production of electricity. Therefore, establishing the management team to begin work on projected excessive rain is critical. Therefore, the development and implementation of this NAP are vital to Liberia's climate change reduction.

Figure 21: Annual means precipitation (Foday, 2020)



Changes in cloud cover, temperature, and pressure patterns directly affect wind and solar resources. As a result, increased intensity and frequency of severe wind and rainfall events could severely impact energy infrastructure. These disruptions could affect Liberia's dilapidated energy infrastructure, leading to long-term power outages and higher prices (Foday, 2020).

Figure 22: coastal-erosion prone area(NDMA, 2020)

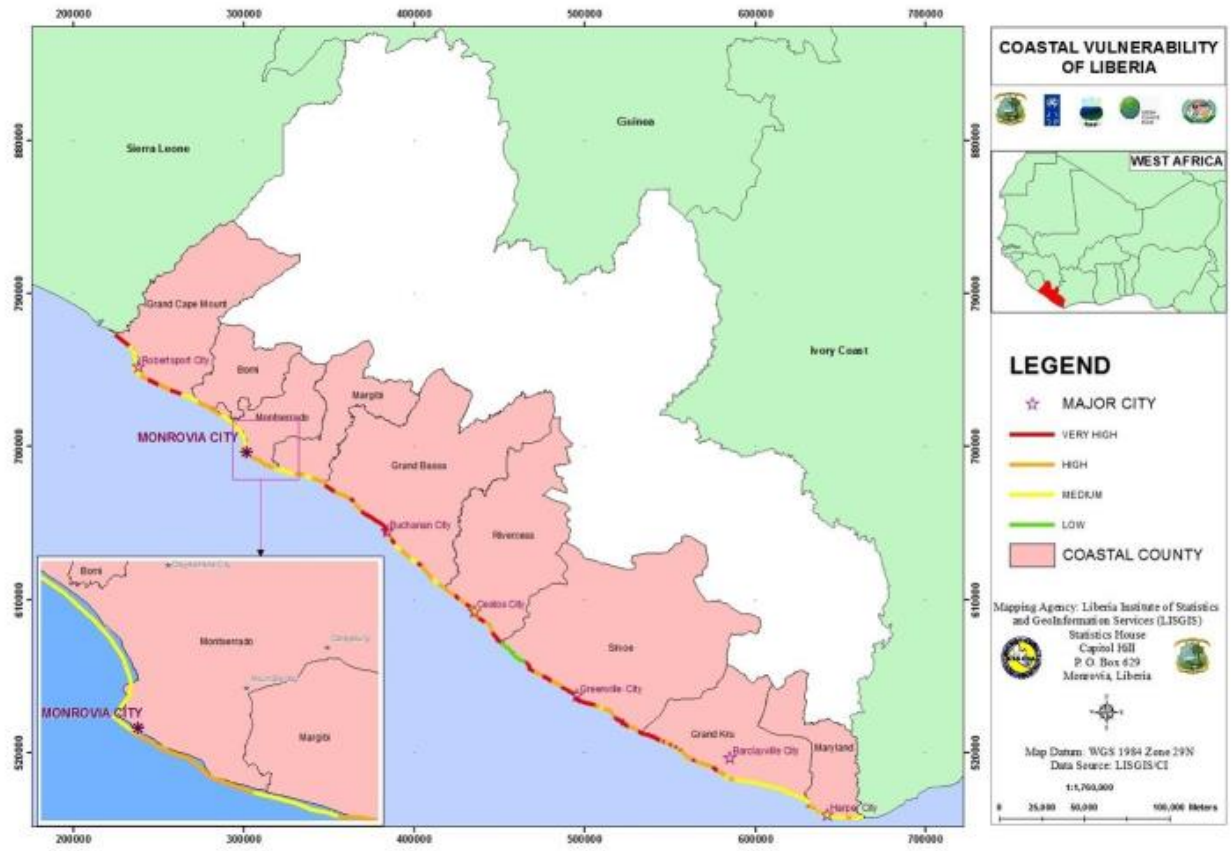
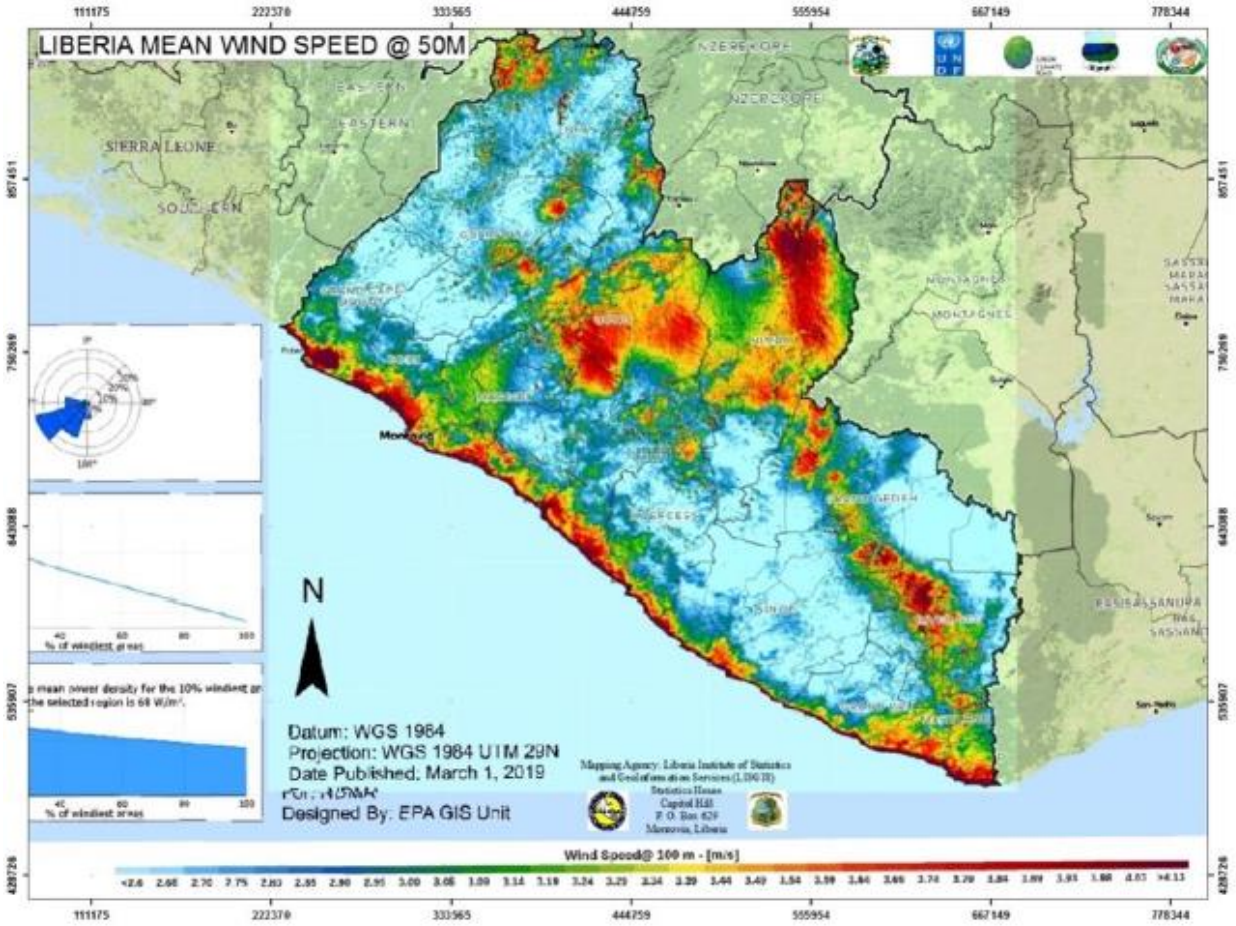


Figure 23: Windstorm-prone areas of Liberia (as of 2019)(NDMA, 2020)



Finally, the vulnerability assessment of the six sectors directly impacts Liberia's socioeconomic sector and poverty. Therefore, developing and implementing an adaptation document is critical to Liberia's growth and developmental agenda. The performance of this National Adaptation Plan Process is associated with the strategic plan outlined in the NDC (2015), NPRSCC (2018), and other policies documents of the country.

CHAPTER 5 ADAPTATION STRATEGIES

5.1. Introduction

In human systems, the process of adjustment to actual or expected climate and its effects to moderate harm or exploit beneficial opportunities is called **adaptation**. In terms of natural systems, adaptation is a process of adjustment to the actual environment and its effects; human intervention may facilitate adjustment to the expected climate and its effects.

Adaptation involves reducing risk and vulnerability, seeking opportunities, and building the capacity of countries, regions, cities, the private sector, communities, households, individuals, and natural systems to cope with climate impacts and mobilize that capacity by implementing decisions and actions (IPCC, AR5). In the context of climate change, risks can arise from potential impacts of climate change and human responses to climate change. Relevant adverse consequences include those on lives, livelihoods, health and wellbeing, economic, social, and cultural assets and investments, infrastructure, services (including ecosystem services), ecosystems, and species.

Adaptation requires adequate information on risks and vulnerabilities to identify needs and appropriate adaptation options to reduce risks and build capacity in framing an approach to transformation[15], engaging people with different knowledge, experience, and backgrounds to tackle and reach a shared approach to addressing the challenges.

Transformative adaptation is a strategy that aims to reduce the root causes of vulnerability to climate change in the long term by shifting systems away from unsustainable or undesirable trajectories. Transformative adaptation is emerging in the scientific and sustainable development debates as both a necessity and an opportunity, but it is a complex concept that remains poorly defined in practice. Policymakers have started recognizing that climate change responses might need to go beyond business as usual to be effective but rarely consider transformative adaptation as a potential solution (Fedele, Donatti, Harvey, Hannah, & Hole, 2019; Few, MOrchain, Spear, Mensah, & Bendapudi, 2017).

As noted in Chapter 1, one of the primary purposes of the NAP Process is to advance the implementation of the adaptation component of the National Policy and Response Strategy on Climate Change (2018). Accordingly, the NAP process is divided into six strategies. The strategies discuss each sector's principal vulnerabilities and management from a climate change perspective and present current guidelines for implementing adaptation measures to increase climate resilience.

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[15] *Transformation refers to a change in the fundamental attributes of natural and human systems such that they are more resilient to the potential impacts of climate change, and such that they are less greenhouse gas intensive.*

During the drafting of these strategies, efforts were concentrated on the adoption of an integrated and systemic approach, based on the premise that the inability of a given sector to exercise its normal activities fully, owing to the impacts of climate change, might directly or indirectly or to a greater or lesser degree, influence the functional stability of other sectors. Likewise, the scope of policies and actions that foster a given sector's adaptive capacity may affect other sectors' resilience.

In setting sectoral and thematic strategies of the NAP, the significant bottlenecks identified for climate risk management are:

- Information and knowledge gaps relating to exposure and sensitivity of human, productive, and infrastructure systems to climate change;
- Identification and spacing of the potential impacts of climate change on Liberian national territory; and
- Decentralized dissemination of climate data and information in plainly understandable language.

In this respect, initiatives that prioritize knowledge management, targeted at generating new knowledge and technologies, power, and access to information are essential for fostering Liberia's sustainable development and economic competitiveness within a context of climate change. Accordingly, the adaptation strategy was developed from the National Policy and Response Strategy on Climate Change (NPRSCC, 2018) and the NDC, 2015.

5.2. Proposed sectors adaptation strategies

The actions proposed are meant to complement or upscale adaptation actions ongoing through various projects and the program being implemented by the nation and county governments, civil society, private sector, and academia; and not duplicate ongoing efforts.

5.2.1. Agricultural Sector

Liberia's agriculture sector is dominated by traditional subsistence farming systems, mainly in the uplands, characterized by labor intensity, shifting cultivation, low technologies levels, and low productivity. While food crop production represents the most important source of livelihood for the majority of Liberia's rural population, with approximately forty-one percent (41%) of the population engaged in the activity, tree crops have represented the highest income–generating sub-sector, providing formal employment to the most significant number of workers in the agriculture sector and contributing significantly to the country's GDP (MOA, 2015).

Table 7: Adaptation strategies of the agricultural sector

Goals	The aim of an adaptation program for the agriculture sector is to foster a secure environment for decision-making on the part of farmers and public policy managers faced with climatic uncertainties through efficient access to information, technologies, and production processes to establish sustainable production systems.
Strategy (NPRSCC, 2018)	• Strengthen the capacity of the Ministry of Agriculture, including training of experts, logistics, and use of technology for the management of the sector. • Improve the effectiveness of pest, disease, and weed management practices through the broader use of integrated pest and pathogen management development and varieties and species resistant to pests and diseases and improving quarantine capabilities and monitoring programs. • Assess crops vulnerability and suitability (cropping pattern) for different Agroecological zones. • Enhance climate-proof agro-infrastructural systems that strengthen the capacity of local farmers to increase productivity. • Support communities in livestock and crop sectors by inventorying and disseminating indigenous knowledge, establishing and/or strengthening insurance schemes, early warning, early action system, vaccination campaign, disease control, etc., to cope with the stress based on climate variability. • Develop and introduce a diverse range of integrated Soil fertility management (SFM), water harvesting, and conservation techniques to farmers as a sustainable means of improving soil fertility, intensifying agricultural production, and coping with extreme conditions (aridity, waterlogging, flood, etc.) • Strengthen the Central Agricultural Research Institute (CARI) capacity for research development of climate smart agriculture initiates in Liberia, including the setting up of seed banks and soil management, crop diversification, immigration, improved livestock breeds, etc. • Develop and implement agriculture technologies and methodologies, including hydrological technology models and scenarios for planning and ensure its promotion through agricultural programs by considering social-economic and gender differences. • Develop climate-resilient crops, promote drought – resistant, flood-tolerant, and establishing gene bank of climate-resilient varieties of indigenous food crops (NDC, 2015) • Develop and support coping strategies such as irrigation infrastructure, intercropping, aquaculture, climate-resilient plant varieties to support the farming system and encourage farmers to engage in them. • Promote the development of sustainable livestock programs for farmers, including grazing management systems. Livelihood diversification (bee harvesting, rabbit, guinea fowl, and indigenous poultry) and breeding animals to adapt to climate change.

Table 7: Adaptation strategies of the agricultural sector

	• Develop a communication strategy to increase farmers' awareness of climate change and strengthen the coordination of existing structures and institutions available to help them adapt to its impact.
Gaps	The strategic plan will address gaps concerning awareness, capacity building, technology, and research.
Indicator	• Number of technical staff at MoA and CARI trained using technology for managerial aspect, integrated pest control, and plants pathogen • Staff end-of-training proportion on a national level and sub-national level using different agrochemical zones to generate crops vulnerability analyses • Increase capacity of subnational-local farmers to increase production using climate-proof agro-infrastructure systems • Number of communities members trained on livestock using early morning warning system base on climate variability proportion to regions • Create a department of research at MoA and CARI and academic institutions to develop a database for soil, seeds banks, climate-resilient crops, and gene banks geographically • Create a department of communication to disseminate climate change adaptation program at MoA and CARI using the EKMS and CCKS • Agricultural risk and vulnerability monitoring system deployed • Climate-resilient crops identify to increase adaptation
Responsibility	• EPA • MOA • UNDP • Universities • Subnational

5.2.2. Coastal Sector

Climate change threatens coastal areas, which are already stressed by human activity, pollution, invasive species, and storms. Sea level rise could erode and inundate coastal ecosystems and eliminate wetlands. Warmer and more acidic oceans are likely to disrupt coastal and marine ecosystems. A rise in seawater level along the coast in Liberia could cause saltwater intrusion into freshwater areas. Flooding is an obvious and immediate threat to economic growth, energy supply, roads and transport, food and agriculture, education, health, water and sanitation, and social protection.

Table 8: Adaptation strategies of the coastal sector

Goal	The development of the strategic plan for the sector to reduce the risk and vulnerability of climate change impacts the coastal sector and disseminate information on the climate change process around the sector.
Gaps	Capacity building, information dissemination (awareness), technology,
Strategies (NPRSCC, 2018)	• develop and implement coastal zone policy, design, and management plan(NDC, 2015) • Assess and build the capacity of agencies and managers responsible for managing coastal adaptive capacity in the sector. • Develop an integrated management plan for coastal zone management as well as an early warning system that includes training and capacity development for coastal management and monitoring • Promote and implement disaster risk management in general (especially disaster preparedness). • Support the rehabilitation and protection of wetlands and mangroves, including awareness and education of their host communities. • Develop and implement a program for climate-proofing new investments in infrastructure (roads, sewers, water supplies, and other infrastructure) in coastal settlements and rural areas to protect continuous access to livelihoods, health care, and education. • Design and implement a strategic communication action plan to inform and educate people about changes and challenges associated with coastal areas related to climate change and how they can adapt to cope with these changes and challenges. • Construct sea walls or revetment (NDC, 2015)
Indicator	• Establish a disaster management team to deal with coastal erosion • Policy and technical documents based on coastal management and modeling • Number of staff trained on the integrated coastal management plan and early warning system • Number of communities trained on wetlands and mangroves management • Number of awareness and education on coastal management, changes, and challenges • New technology to reduce or improve coastal erosion deployed. • Number of regional centers established • Number of coastal management teams established • Percentage of the work plan completed
outcomes	• Qualification of information for studies and projects on Liberia coastal zone • Promote and disseminate knowledge on coastal zone management

Table 8: Adaptation strategies of the coastal sector

	• Policy and regulations of coastal zone established • Qualification of information for studies and projects on Liberia coastal zone
responsibility	MME EPA Subnational

5.2.3. Energy Sector

This strategy aims to improve energy efficiency and conservation and develop Liberia's domestic energy resources to facilitate private sector participation and investment in the new low-carbon energy sector. Seasonal and daily temperatures and precipitation changes would affect the timing of peak electricity demands and the size of the peaks. For instance, very hot days and nights are already being observed in some parts of the country (e.g., Monrovia), increasing electricity demand to cool residences and businesses. In addition, extended periods of drought could reduce water availability for hydropower generation, particularly in parts of the land projected to be heavily hit by increased temperatures, which are also origins of significant rivers in the country.

Table 9: Adaptation strategies of the energy sector

Goal	The strategy will reduce the risk and vulnerability of climate change impacts on the energy sector, thereby sustaining energy production.
Gaps.	Capacity building, Research, Technology, Financing
Strategies (NPRSCC, 2018)	• Establish and promote a robust national program on solar energy (e.g., hybrid systems, installation of solar panels, promotion of solar street lighting, etc.) and other energy-efficient lighting technologies. • Support the provision of energy-efficient technologies such as energy-efficient bulbs to provide power and lighting for schools and other public institutions and households as a means of enhancing or introducing energy-efficient technologies. • Support the promotion and implementation of energy plantation schemes to minimize natural forest pressure and reduce energy stress. • Develop a system to regulate the sustainable use of biomass energy. • Promote and support the development and utilization of community-based off-grid/mini-grids. • Conservation and protection of water catchments, including around hydro-power and municipal water supply sources. • Prevent sedimentation that could hinder the production of energy in hydroelectric facilities

Table 9: Adaptation strategies of the energy sector

	• Enhance implementation of an energy generation mix plan that increases the resilience of the current and future energy systems to the impacts of future climate variability and change. • Establish Protection of water catchment around hydropower sources (NDC, 2015).
Indicator	• Number and frequency of analyses undertaken on water catchment surveillance • Catchment water quality is known • Number of climate-resilient infrastructures established • Renewable energy policies develop • Establish new technology on clean energy production • Number of staff or local communities trained on the production of biomass energy • Renewable energy policy developed and deployed.
Outcomes	• Assist with the planning process to monitor catchment around hydropower source • Strengthen government policy on renewable energy • increase energy availability in rural areas and promote sustainability
Responsibility	• EPA • MME • LEC • Subnational

5.2.4. Fisheries Sector

Climate-induced changes in the biophysical characteristics of marine and freshwater areas in Liberia and extreme events will have significant effects on the ecosystems that support fish (especially inland). This will affect food security in multiple ways. These include loss of some fish species due to extinction and low productivity to support local consumption, migration of many fish species to aquatic environments with optimal climatic conditions beyond Liberian waters (those that are inaccessible to fishers), lower earnings from fish export due to reduced fish production, consequently reduced capacity to import food and exacerbation of food insecurity locally, and fisheries products and supplies. Hence, with the predicted increase in the demand for fish products, efforts to support food and livelihood security need to be informed by predictions of climate change's impact on fish production and its associated social and economic consequences.

Table 10: Adaptation strategies of the fisheries sector	
Goals	To reduced climate-induced changes in the ecosystems that support the fisheries sector.
Gaps	Capacity building, technology
Strategies	• Strengthen the capacity of the Bureau of National Fisheries, including staffing and logistics for research monitoring and enforcement. • Invest in and support artisanal fishing communities, including training, fishing gear, and alternative livelihoods. • Set up robust monitoring, reporting, and verification system that captures and reports timely and accurate changes in the stock of productivity and pressure on fisheries; and implement adaptive management practices for managing the sector. • Support research to fully understand pressures on fisheries related to climate change impacts and identify appropriate measures, including diversification of livelihood portfolio of fishery-dependent communities. • Identify, map, and protect areas valuable for fisheries (e.g., deep pools in river systems that serve as spawning areas), including the setting up of marine protected areas. • Support the establishment of a system to reduce external stressors on fisheries by instituting changes in a vessel or gear types as well as instituting actions and regulatory measures to reduce land-based sources of pollution (e.g., agricultural, and urban runoff) and destructive fishing practices (e.g., fishing with explosives and poisons). • Integrate fisheries fully into climate change adaptation and food security policies at the national level (draft and enact where non-existent) to ensure incorporation into broader development planning. • Support the diversification of the livelihood portfolio of fishery-dependent communities. • Support the establishment of early warning systems to identify probable threats and risks related to fisheries. • Support the establishment of improved information and communication networks for decision making and planning and between fishing communities to support information sharing about potential shocks in the system. • Establish a monitoring system for fishery management and climate change • Establish a surveillance system to promote a smart fishery system (NAPA, 2008) • Promote sustainable fishing practices and policies Regulate fishing practices to prevent overexploitation and fishing in restricted areas (NAPA, 2008) Conduct capacity building among the sector
Indicator	• A fishery monitoring system established • Number of staff of governmental and non-governmental agencies trained-capacity enhanced • An appropriate surveillance system for fishing established • Number of staff at the Bureau of National Fisheries trained

Table 10: Adaptation strategies of the fisheries sector	
	• Establishment of a department of research at the Bureau of Fisheries to understand climate vulnerability assessment fishes • Spatially develop marine protected areas • Establish and deployed Bureau of Fisheries surveillance team • Number of the early warning system and monitoring system established to a reduced external stressor on fisheries • Community trained on sustainable fisheries activities
outcomes	• Foster incorporation of information on climate change into the policies sector involved • Climate-smart fishery systems establish
Responsibility	• NaFAA • MoA • EPA • Subnational

5.2.5. Forestry Sector

Like other natural resource sectors, Liberia's forests are anticipated to be impacted by climate change. It is acknowledged that warmer temperatures and precipitation changes can affect tree growth, engender an increased proliferation of insects and pest control, and ultimately, the forestry sector's productivity. Also, extreme weather events (hurricanes and storms) can result in uprooting trees and commercial value and revenue loss. It is estimated that the adverse impacts of climate change will contribute to the destruction of forests and thereby promote greenhouse gas emissions, which will enhance global warming.

Table 31: Adaptation strategies of the forestry sector	
Goals	To reduce risk and climate change vulnerabilities of the sector implementing strategies
Gaps	Capacity building, Technology, Finance
Strategies (NPRSCC, 2018)	• Strengthen the capacity of the FDA, including training of experts and logistics for forest management • Implement sustainable and, where applicable alternative livelihood initiatives for forest-dependent communities; to enable them to become less reliant on forest resources; • Promote community forest activities beyond timber extraction as a management tool for sustainable forest using indigenous species and knowledge. • Establish a comprehensive monitoring system for forest resources by building on existing systems (including non-timber forest products) to detect changes in the conditions of the ecosystem services provided by forests.

Table 31: Adaptation strategies of the forestry sector	
	• Implement reforestation and afforestation activities in degraded areas, increase rural income, and improve biodiversity richness, including wild fauna. • Identify and map for proper management of water catchment areas in forests that are valuable to communities. • Promote the consolidation of protected area network by considering landscape approach, ensuring that it consists of a large spectrum of forest types across various environmental gradients and enhance connectivity between habitats. • Establish and/or strengthen coordination mechanisms with other line ministries and agencies that might implement activities that affect forest and wildlife and ensure that the principle of sustainable forest and wildlife management is mainstreamed in national and sectoral policies and programs. • Enforce regulations related to illegal hunting to eliminate poaching and implement an environmental 'Code of/ethics in the wildlife sector. • Develop and implement a communication strategy to increase the awareness of relevant stakeholders, particularly forest-dependent communities, about the impact of climate change and how they can adapt to these changes.
Indicator	• Progress of ongoing activities on awareness and forest management and mapping • Progress on forest management and mapping improves. • Established and trained forest management team • Community education on the forest management and community forest management • Trained in geo sensing to monitor forest • Awareness and dissemination on forest management
Outcomes	• Awareness improves forest management • Forest protected • Identification of reforestation
Responsibility	• EPA • Subnational • FDA • MOA

5.2.6. Waste Management Sector

Municipal solid waste (MSW), including everyday waste from households, schools, and business places, contains biodegradable organic matter such as kitchen waste, garden waste, and paper, which generates a mixture of carbon dioxide and methane upon their degradation. Municipal solid waste landfills are the third-largest source of global methane emissions. Simultaneously, the practice of open garbage

burning emits black carbon and other toxic compounds and greenhouse gases. A few years ago, the uncontrolled dumping and burning of garbage were quite common as a form of final disposal throughout Liberia. Such practices, compounded by inadequate waste collection systems and the lack of technical and environmental controls, are not only problematic because of the emissions into the atmosphere but also because of the impact on the health of the population and pollution of the nearby ocean, thereby affecting coral reefs and affecting the livelihood of thousands of Liberians whose livelihoods are directly and indirectly linked to fishing and eco-tourism. Addressing the impacts of Climate Change on the waste sector will involve various interventions involving adaptation and mitigation. It will look at the potential of existing waste management options for decreasing emissions and efforts to address related impacts associated with flooding, disasters, and sea-level rise.

Table 42: Adaptation strategies of the waste management sector

Goals	To reduce climate change vulnerability and risk factors relating to the emission of greenhouse gases from waste disposal.
Gaps	Technology, Capacity Building, Finance, Research
Strategies (NPRSCC, 2018)	• Strengthen capacity at the community and institutional level for integrated waste management. • Develop an integrated waste management strategy and system for all types of waste, assigning priority to prevent waste generation with nationally appropriate low greenhouse gas emission technologies that are well managed and compatible with methane capture and use for electricity generation. • Promote private-public partnership (PPP) and other ventures that attract financing for infrastructure investments in the waste sector. • Design and implement a system to run urban waste into input for agricultural production through composting waste for use in food security programs in the urban (urban agriculture) and rural areas. • Develop landfills for all major cities and use the Clean Development Mechanism (CDM) and Nationally Appropriate Mitigation Actions (NAMAs)to develop methane recovery and power generation projects in landfills.
Indicator	• Personnel trained on waste management integration • Encourage private-public partnership to improve on waste management • New technology to transform waste into agriculture products to electricity production deploy • Construction of withholding landfill for major cities • Progress on solid waste management

Table 42: Adaptation strategies of the waste management sector

	• Number sector members trained • Introduction to new technology
Outcomes	• Integrate solid waste management into climate change risk management • Increase Liberia's capacity to face up the negative aspects of climate change, and significantly impacts that affect waste management
Responsibility	• MCC • EPA • Partners • Academic Institution • Subnational

5.4. Cross-cutting action

5.4.1. Water Resources Sector

Alterations in temperature and rainfall patterns brought on by climate change are likely to cause significant impacts on water availability (volumes and distribution), affecting the multiple uses of water and the general population. Extreme water-related climate events (flooding and drought) are likely to become more intense. Given the indispensability of water, water-related issues are likely to be among the first global climate change impacts felt by populations.

Flooding and drought have increasingly caught the public's attention, not merely due to their economic and social impacts but also because of mass media coverage. It should, however, be remembered that impacts of extreme events attributed to climate change may also be exacerbated by other pressures on water resources, including inappropriate land use and settlement in river basins, increasing demand for urban water supply, agriculture, and power generation; the intensification of processes that impair water quality, higher exposure of populations, and increased anthropogenic intervention. The intensification of processes that impair water quality is higher exposure of people and increased anthropogenic intervention.

Table 13: Adaptation Strategy-Cross-Cutting Water Resources	
Goal	to develop integrated climatic and hydrological models and assess their impacts on water resources management.
Gaps	Capacity building, technology, finance
Main Action	This sector hopes to deliver the following results: • Fast-tracking the implementation on the mainstreaming of climate change into water resources management • Establishing a surveillance team on water resources vulnerability

Table 13: Adaptation Strategy-Cross-Cutting Water Resources	
Responsibility	• WASH-Liberia • EPA • Liberia Water & Sewer Corporation (LWSC) • Ministry of Health (MoH) • National Public Health Institute of Liberia (NPHIL)

5.4.2. Biodiversity

In general, feedback on public awareness and perceptions of conservation of biodiversity, the maintenance of ecosystem services, and increasing the adaptive capacity of biodiversity and society to impact climate change have been challenging. However, in recent years, a new approach for addressing climate change effects, known as ecosystem-based adaptation (EbA) that relies on ecosystem services to reduce human vulnerability to climate change, has gained ground among managers and researchers.

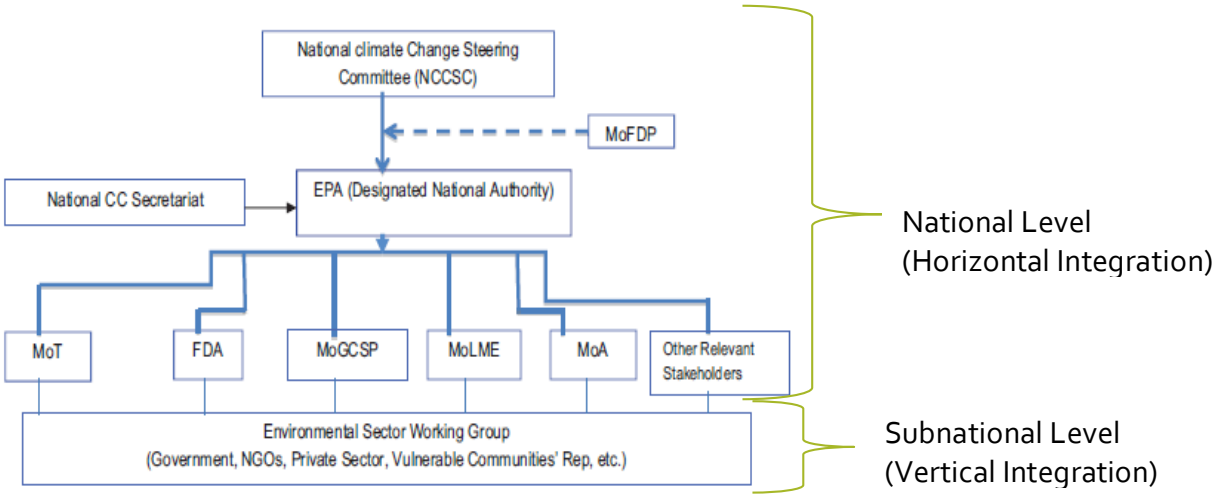
An EbA approach is based on the use of management, conservation, and recovery of ecosystems to enhance ecosystem services that enable society to adapt to the impacts of climate change. Benefits of EbA strategies include reduction of the vulnerability to gradual and extreme events, maintenance of the ecological integrity of ecosystems, carbon sequestration, greater food security, sustainable water-resources management, and an integrated approach to territorial management, all of which generate multiple economic, social, environmental, and cultural benefits for society.

Table 14: Adaptation Strategy – Cross-Cutting Biodiversity	
Goal	Preparation of ecosystem-based adaptation strategy measures in areas at risk of extreme events and climate change impacts
Gaps	Capacity building, technology, finance
Main Action	This sector hopes to deliver the following results through the establishment of a working group to • conduct a scoping study to identify and prioritize areas for Eba measures and to recommend specific approaches, institutional arrangements, and financing option • Conduct (nationwide/regional) assessments on potential climate change impacts on biodiversity and ecosystems." • Fast track the integration of Ecosystem-based Adaptation (EbA) approaches into Liberia's overall adaptation response to climate change
Responsibility	• EPA • Partners

5.5. Institutional Arrangements for Climate Change Adaptation

An essential step in addressing the impacts of climate change, either through adaptive actions, involves having a functioning institutional structure to coordinate climate change initiatives across all sectors at the national and sub-national levels. However, current governance structures on climate change and institutional arrangements (NPRSCC, 2018) are critical to providing the NAP process's governance. Therefore, the institutional arrangement of the NPRSCC, 2018, to implement the NAP Process is of two categories: (1) National Level (horizontal coordination) and (2) subnational level (vertical coordination).

Figure 24: NAP Process Institution arrangement



5.5.1. National Level (Horizontal Arrangement)

The National Level (horizontal arrangement) includes line ministries and agencies, the EPA, National Climate Change Secretariat (NCCS), and National Climate Change Steering Committee (NCCSC).

Table 15: National level actor function

National Level	Primary role to the implementation of the NAP Process
NCCSC	- Validate (bi-annual) and secure government support for the implementation of the NAP Process - Supervise and provide the leadership for the overall coordination and activities of the NAP Process - Report bi-annual on the progress of the NAP Process to the President of the Republic of Liberia and Head of Standing Committees on Environment and Natural Resources of the Houses of Senate and Representative, respectively

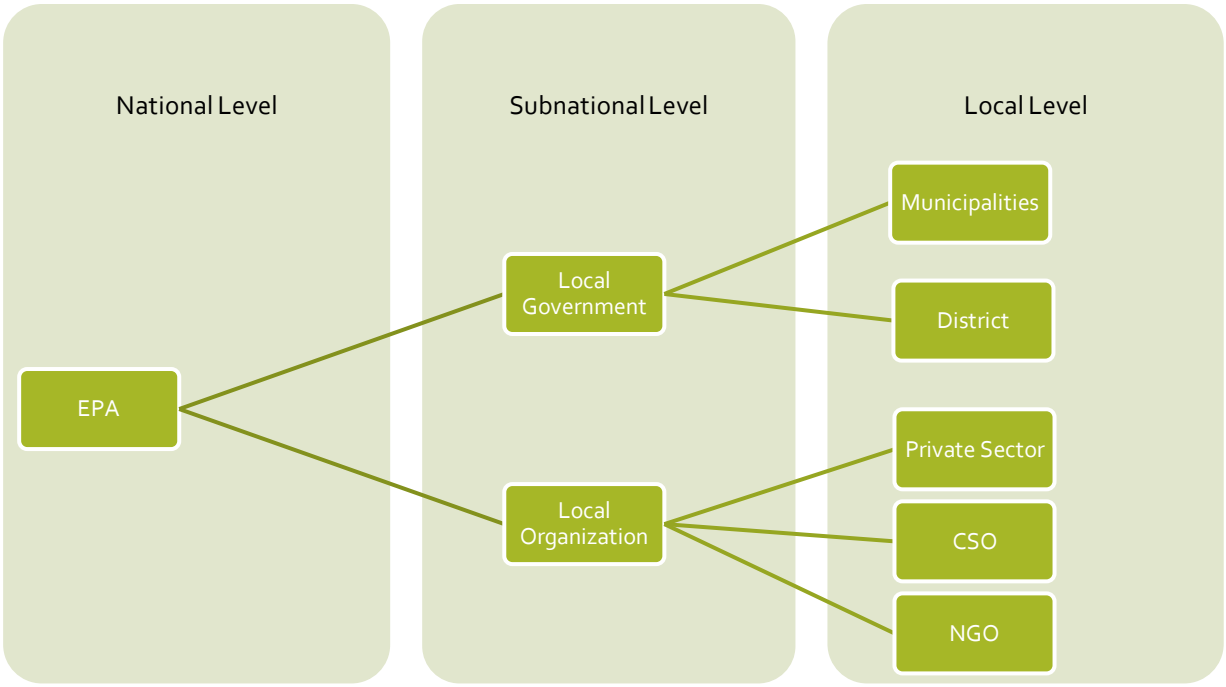
National Level	Primary role to the implementation of the NAP Process
	- Engage cabinet and the legislature to secure funding for the implementation of the NAP Process
EPA	- The EPA shall be the led agency on the implementation of the NAP Process - Coordinate the NAP Process consultation with the Ministry of Transport (MoT), Forestry Development Authority (FDA), Ministry of Gender, Children and Social Protection (MoGCSP), Ministry of Mines and Energy (MME), Ministry of Agriculture (MoA), and other relevant sectoral institutions - Work with a local organization to establish the vertical integration that reports to the EPA monthly
NCCS	- Track the progress on the implementation NAP Process - Serve as liaison between the NCCSC and the EPA and various working groups on the implementation of the NAP Process - Engage in appropriate programs to strengthen national capacity during the NAP Process - Collaborate with an international organization, academic institutions, and experts to implement the NAP Process - Maintain full records of the proceedings of the Climate Change Steering Committee.

5.5.2. Vertical Integration

In the context of the NAP process, vertical integration creates intentional and strategic linkages between national and sub-national adaptation planning, implementation, and monitoring & evaluation.

Vertical integration is driven by recognition of sub-national diversity in vulnerability to climate change, as well as the important role played by sub-national authorities and local organizations in advancing adaptation. The sub-national are institutions, systems, and processes at a level below the national level, including the local level. The subnational relative to Liberia is Local Government and Local Organization. The local organization are Non-governmental Organization, Civil Service Organization, Private Sector operating in Liberia. The local government are the district and municipalities. Effective vertical integration requires an explicit commitment from national actors to have an inclusive and participatory NAP process, with ongoing dialogue between national and sub-national actors throughout all stages.

Figure 25: Vertical integration actor distribution

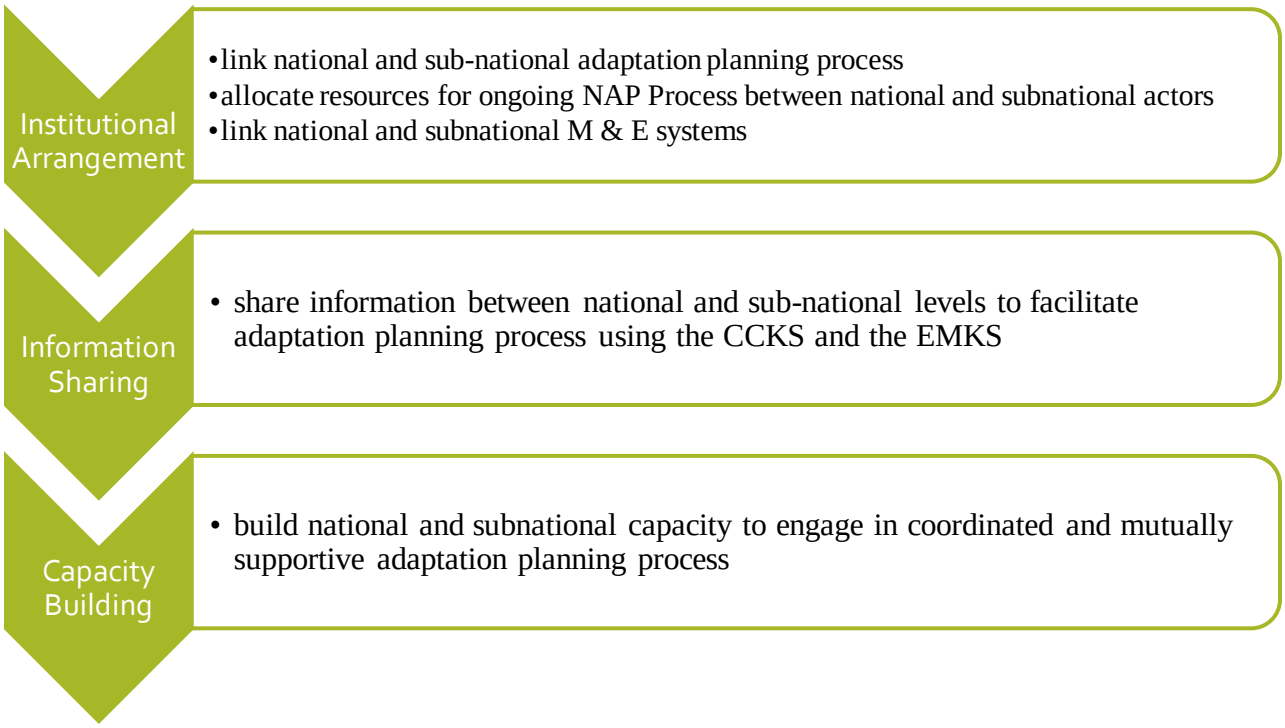


As many of the impacts of climate change are felt most acutely at the local level, it is vital that the people at the forefront of climate change—those experiencing the impacts—really have a say in national-level policy. Therefore, it is imperative for GoL through the EPA to engage in forming Local Adaptation Plan Committee that will aid the national level in implementing the NAP Process. The Local Adaptation Plan Committee will also develop local-level adaptive capacity-building, and experiential facilitate the local community. A recent guidance note defines vertical integration as "creating intentional and strategic linkages between national and sub-national adaptation planning, implementation and monitoring & evaluation (M&E).

The NAP stresses the importance of vertical integration with good reason. The vertical integration links to the decentralization process and highlights the need to integrate climate change adaptation into national and sub-national structures, including developing district development plans. Information sharing and capacity building will be critical for successful vertical integration and should be planned by the EPA. Vertical integration provides an opportunity to overcome many of the barriers to adaptation. For example, sub-national governments may find it difficult to generate resources and financing for adaptation activities; through vertical integration, closer links with national-level frameworks and a closer link with national

governments can help facilitate flows of finance, either from national funds for Climate Change or through international funds like the Green Climate Fund.

Figure 26: Enabling factors for Vertical Integration in the NAP Process



In collaboration with the Environmental Protection Agency, the Ministry of Internal Affairs will play the lead role in coordinating with the government's subnational levels. The EPA will provide experts that will work with the communities at the district and village or community. The subnational level be divided into committees at the district and village of community. The implementation of the adaptation strategies projects should be at the subnational (districts/villages).

5.6. Resource Mobilization

Adaptation has been financed through various mechanisms in the country. Often the actions have not been termed adaptation; their actions have enhanced resilience to climate impacts. However, information on the amount of finance that has gone into adaptation is important. The total costs of this adaptation financing will need to be determined so that additional financing complements existing funding.

GoL through the EPA needs to establish mechanisms to help increase access to climate finance, including the Green Climate Fund, and improve coordination and reporting on climate finance. This NAP envisages that the government's adaptation actions do not, yet finance will attract financing from

development partners and the private sector by developing a pipeline of adaptation investment-grade projects and programme.

Liberia, through the NAPAs, integrated climate change concerns into several activities, including the National development planning from the perspective of finance and planning, the vulnerability of Liberia climate change on the agriculture, fisheries, forest sectors, health, energy, and the coastal areas. The NAPs implementation also led the government through the EPA to progressive policies and planning on climate change. Some of the policy documents include the National Planning Framework and the National Climate Change Policy. In addition, part of the NAPs activities was Capacity Building, the University of Liberia Master Program in Environmental Studies and Climate Change to educate Liberians on adaptation assessments. Since the inception of the NAPs, the managerial team has conducted several projects, and below (Table 17) is a summary of the project documents.

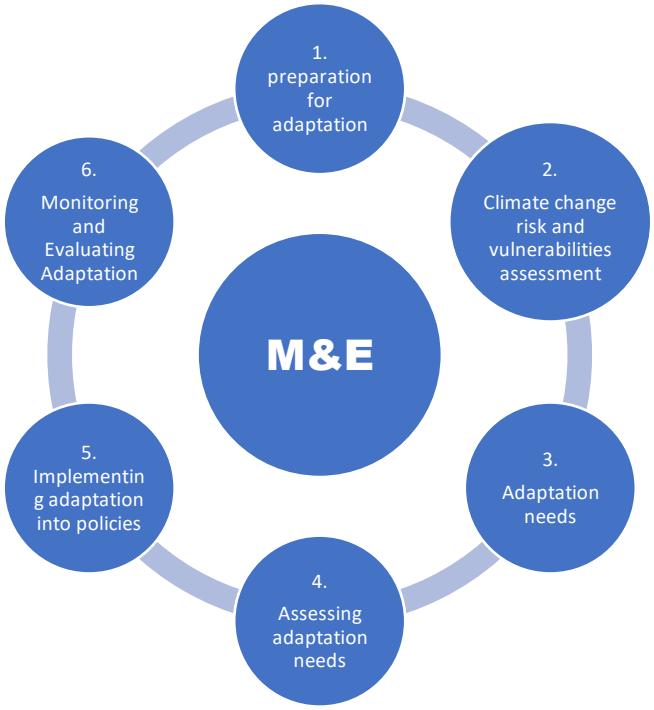
However, the Environmental Protection Agency (EPA) in partnership with the Ministry of Finance and Development Planning (MFDP) will establish the climate public expenditure and institutional review (CPEIR) and Climate finance tracking system. The CPEIR will identify existing expenditures on climate change and will help to identify on-budget entry points where climate change could be incorporated into the national budget.

CHAPTER 6 MONITORING and EVALUATION

6.1. Introduction

This chapter outlines the monitoring and evaluation (M&E) system for the National Adaptation Plan. Monitoring and evaluation are essential parts of ensuring that the prospective benefits of adaptation interventions to build adaptive capacities and enhance resilience are realized, and lessons learned to improve the Government of Liberia sector plans and programs. Therefore, any M&E system needs to have a feedback mechanism that will ensure the continued building of resilience and reduce vulnerabilities to climate change in the longer term. As a result of the need to track progress in building adaptive capacity, a theory of change has been developed, and indicators have been proposed against the significant changes expected in resilience until 2030. Therefore, the adaptation M & E is categorized in the cycle below:

Figure 27: Monitoring and Evaluation cycle



The reporting, monitoring, and review will collect information on the progress of NAP implementation, assess it through a national M&E system, and provide outputs for the reporting on progress to the UNFCCC's Conference of Parties (CoP). This chapter's activities would be implemented throughout the NAP, starting with the design and launch of the M&E system during the launch of the NAP. The review outcomes would inform regular updates of the NAPs, and lessons learned would be integrated into subsequent actions of the NAP.

The main output of this chapter would include a plan for monitoring and evaluation, with a plan for data collection and ongoing compilation and synthesis of new information on impacts and vulnerabilities to be

used in updating the NAPs. The NAP would be disseminated internationally and through the UNFCCC secretariat. Regular progress reports would also be submitted to the UNFCCC through existing and new reporting channels, including countries' national communications and submissions.

6.2. Monitoring Framework (NPRSCC, 2018)

Each ministry or agency is supposed to conduct internal monitoring processes during the entire NAP implementation process so that they be able to rectify problems as they exist and enhance good achievements. They will prepare periodic monitoring reports (quarter and annual reports) on the achievements of the adaptation strategies in their sector and submit them to the EPA. EPA will organize and provide technical backup and capacity building on the monitoring process. EPA will also prepare aggregate quarterly and annual national summary reports on the achievements obtained and challenges encountered, including proposed remedial measures, and submit them to the Ministry responsible for National Planning and the higher body assigned by the President's office, as explained in section 9.1, of NPRSCC 2018.

6.3. Evaluation Framework(NPRSCC, 2018)

Evaluating the implementation and effectiveness of the response Strategies stated under each sectorial and cross-sectorial policy will be conducted at different steps in the process. The first type of evaluation will be conducted during the whole implementation period on an ongoing basis, starting from the approval by the GoL. The second type of evaluation is the short-term evaluation, the third is the mid-term evaluation, and the other is final evaluation. The first type of on-going evaluation (mainly quarterly and annual) will be conducted internally by each sector to track the implementation of the strategies undertaken by relevant sectors and integrated into their development plan. Periodic (quarterly and annual) aggregated monitoring reports of the sectors will be the basis for this evaluation. As a lead Agency, the EPA will lead and conduct annual assessments on the implementation of the Strategy by the respective sectors and report the findings to NCCSC.

Table 16: Monitoring, Evaluation, and Reporting of the NAP

Steps	Indicative activities
1. Monitoring the NAP	a. Identify areas of the NAP that will be monitored through qualitative and quantitative performance measures to determine progress made towards the NAP's objectives, b. For the areas that will be identified for monitoring, define metrics for documenting progress. Concerning evaluation, determine means for measuring and communicating levels of effectiveness and assessing gaps c. Collect information on the metrics throughout the NAP
2. Review the NAP process to assess progress, effectiveness, and gaps - Evaluation	a. Compile and synthesize information from new assessments and emerging science, as well as the results and outcomes from adaptation activities being implemented, to support the review and update of the NAPs b. Regular revision of the NAP by evaluation information and metrics
3. Iteratively updating the NAP	a. The GoL through the EPA must update the NAP relative to information collected b. The EPA work towards aligning the production of updates to the NAPs with relevant national development plans
4. Outreach on the NAP and reporting on progress and effectiveness	a. EPA and its partners must disseminate the NAP document b. Provide information in national communication on progress in and effectiveness of the NAP

6.4. Adaptation Reporting and Lessons Learned

Key institutions mentioned under each sector are expected to integrate the proposed adaptation actions into their sectors. Key sectors' action plan could be submitted to the EPA and follow with establishing a hub that could meet frequently meet at the EPA. These sectors and universities will work with the EPA in the implementation of the NAP process. In so doing, the key sectors will be implementing the NPRSCC. They will also report progress on implementing the actions annually to the EPA of the Climate Change Secretariat. Learning from the implementation of climate change adaptation activities in the country will need to be collected and submitted to policymakers to influence future adaptation implementation and decision making. It is proposed that lessons learned to be captured from implementing stakeholders across the country through the proposed knowledge management system. The knowledge management system will be housed in the EPA and other web-based systems such as the environmental knowledge management sharing platform (EKMS).

CHAPTER 7 CONCLUSION

7.1. Conclusion

Like the rest of the global community, Liberia's climate change is associated with the potential devastation of livelihoods. Climate change risk and vulnerability can be experienced in every part of the priority sectors in Liberia. All populations are affected by climate change, but some are more vulnerable than others. Children living in developing countries are among the most susceptible to the resulting health risks and will be exposed longer to the health consequences. The health effects are also expected to be more severe for older people and people with infirmities or pre-existing medical conditions. Liberia, with a young population, is critical to developing an adaptation plan to combat climate change.

Climate change has intensified environmental degradation, decreased agricultural production and food security, increased flooding incidences, landslides, disease epidemics, damaged physical infrastructure, and reduced the risk of competing natural resources. Even though the susceptibility to such impacts is discrete and context-specific, it has the potential to contribute to substantial economic costs that could impede the achievement of the Pro-Poor Agenda for development and prosperity.

Therefore, the National Adaptation Plan process offers a broad, coordinated, structured mechanism for government, private sector, civil society, and other stakeholders to incorporate climate change and variability considerations into national development planning and implementation at different levels.

Liberia, through the EPA, needs to integrate climate adaptation considerations in policy and planning. Adaptation is simultaneously being considered at the national level, in some sector-specific planning, and to a lesser extent in selected local development plans. In structuring the NAP process, the EPA will have to coordinate the national adaptation plan's development with adaptation priorities identified in crucial sectors such as agriculture, forestry, water resources, energy, gender, and health. Sectoral priorities have been identified by developing climate change vulnerability assessments for critical sectors, and local adaptation priorities will be determined through developing stand-alone adaptation plans Therefore, it is imperative to propose a long-term vision is to develop stand-alone adaptation plans at the district levels.

7.2. Recommendations

Engaging the Private Sector. Liberia’s economy is very reliant on primary sector activity (extractive industries), and that these are a key part in the future development of the economy, but that value chains are potentially very vulnerable to climate change, and so private sector stakeholders need to begin to consider climate risk and the potential impacts of climate change on their operations and viability.

A successful NAP process will require leveraging the private sector in climate change adaptation. Private entities dominate many decisions critical to adaptation (e.g., the location and design of roads, buildings, and other infrastructure investments, which are often minimally regulated by codes); agricultural research (e.g., to develop more drought-resistant seeds); water management infrastructure and technologies; the commitment of financing, much of which will necessarily have to come from private sources; the development of adaptive technologies in all development sectors; and the development and dissemination of adaptation products and services. The private sector's critical need for climate change adaptation is that 90% of people in developing countries depend on the private sector to generate income. . To expand the private sector's participation, the NAP process should include the mainstreaming of climate change adaptation into regulations and work programs relating to the private sector, which is critical to Liberia's NAP process. Through the EPA, Liberia's government must build a conducive business environment that enables the private sector to take the initiative on climate change adaptation. For instance, private companies could be given tax incentives to invest in climate change adaptation measures. Furthermore, an environmental certification system could be developed to reward companies that apply credible climate resilience principles to business.

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